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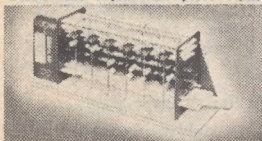
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A MONTH AGO, I had the wild experience of standing in a crater on the moon. Above the craggy horizon, earth hung in black space like some gigantic, luminescent blue bauble on a vast Christmas tree studded with stars. Actually, we were in the Radio Corporation of America's Johnny Victor Theater in New York. We were looking at a visual display of the incredibly compact communications equipment that will keep our astronauts in touch with their moon-orbiting mother ship, Houston Control—and each other. It was a remarkably vivid portrayal of the vital

THIS MONTH

system, in spectacular color, and you'll be seeing it in *Science Digest*.

Meanwhile, our contributing editor, Bruce Frisch, has been digging up little-known facts about United States plans for the first man-on-the-moon expeditions. He found that many of the curious moon vehicles that will be used by our moon pioneers for the various exploratory missions they'll make over a landscape ruptured by craters and ridges, already exist. He wheedled pictures of several unique ones, and spent hours out at Grumman's lunar proving grounds on Long Island, taking photographs of their moon "Rover"—the weird-looking runabout you see on the cover of this issue. "It would be a great fun machine," he reports. "Its high sprung-to-unsprung-weight ratio makes it better than any sports car on corners and bumps. It rides flat as a platter. It would be an ideal beach buggy that drives effortlessly." To find out how our moon explorers will use it, and where they'll drive it, see page 42.—RFD

SCIENCE

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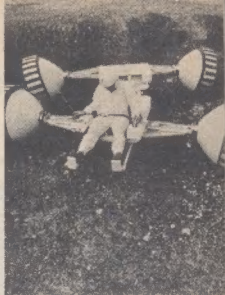
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DIGEST®

When our astronauts make their first real visit to the moon, possibly this July, they'll be collecting lunar samples and placing scientific instruments on its surface. But for later trips, when exploration will be of prime consideration, the astronauts will need transportation. This moon buggy, the Lunar Roving Vehicle (LRV), is expected to be ready by 1973. For the story of our astronauts' route and schedule, see page 42.

Cover photo by Bruce Frisch.



APRIL • 1969

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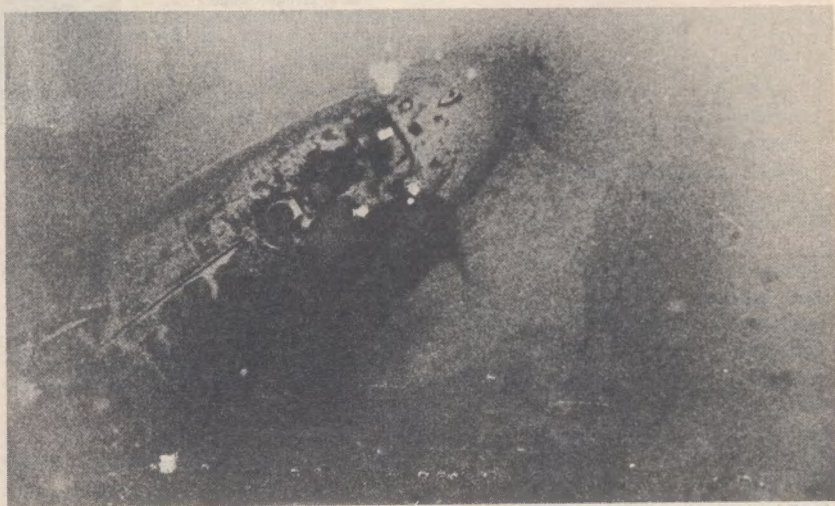
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NEWS IN BRIEF

Bulletins at press time



Pictorial Parade

DETAILED PHOTOS OF THE NUCLEAR SUB, "SCORPION," taken at a depth of two miles, some 400 miles southwest of the Azores, told Navy investigators that the giant submarine had not hit a sea mount, nor was there any evidence of trouble with the nuclear powerplant, or of sabotage. Cause of the disaster still has not been determined.

ANOTHER BREAKTHROUGH IN SYNTHESIS OF VITAL MATTER was achieved with the chemical construction of an enzyme by two teams of scientists working independently. The enzyme synthesized is ribonuclease (RNase) that destroys ribonucleic acid (RNA) after it has directed the manufacture of proteins in a cell. Enzymes are catalysts that run the body; build tissues, blood, hormones and other enzymes. While RNase itself has no immediate application, it may lead to synthesis of other enzymes. Some have shown promise in fighting a form of leukemia, embolisms and many other diseases.

INSECTS ARE GOOD TO EAT, and there's no real reason why people shouldn't get over their silly prejudices and start putting bugs on the menu. That's the word from Dr. Ronald L. Taylor, University of California, who

serves up fried caterpillars and chocolate-covered grasshoppers to his students. His reasoning: help stave off world food shortage. Bugs are high in protein, he says, and are delicacies in many countries. In the Far East grasshoppers are toasted, fried, boiled, curried, baked and chomped raw. Termites and caterpillars are big in Africa. Toasted ants are sold like popcorn in some countries; in others they're mashed in water to make a popular drink.

CANCER PATIENTS WILL BE ABLE TO CURE THEMSELVES with one of their own natural body substances, if experiments at the National Institute of Allergy and Infectious Diseases, Bethesda, Md., continue to be successful. Drs. Hilton Levy, Lloyd Law and Alan Rabson have found that the body substance interferon has the ability to resist and often kill cancer cells and inhibit viruses that cause them. An injection of a synthetic chemical into the body that stimulates production of interferon has been shown to be effective in curing certain cancers in white mice.

OUR WORKING SATELLITES ARE REMAKING THE WORLD. Pictures from space are changing our maps -- sometimes radically. Latest revisions involve areas of forbidden Tibet, last mapped by Explorer Sven Hedin. Vast changes in shoreline configuration of big lakes show clearly in the space photos, along with mapping errors involving other terrain features. Authorities believe we'll soon have the most accurate world maps in history. What's more, we'll be able to stay current with changing land forms and moving shores.

WORLDWIDE DAMAGE FROM DDT POLLUTION has been achieved, says Dr. Charles F. Wurster, molecular ecologist at the State University of New York at Stony Brook. Pesticides such as DDT "should no longer be tolerated," he claims. The reason: DDT and certain other pesticides do not break down into their component parts but remain for years in soil and waterways, building up not only in the bodies of wild creatures but also in human beings. Wurster points out that there are other pesticides just as effective as DDT but that do not linger in the environment. He attributes the death of about a million coho salmon fry last year at Michigan and Wisconsin hatcheries to indiscriminate use of DDT.



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Six cave explorers who lived outside of time

by Walter S. Ross

AS YOU READ THIS, two young Frenchmen, Jacques Chabert, 28, and Philippe Englander, 30, are recuperating after almost five months of living in separate, unconnected caves, more than 225 feet beneath the snow-covered slopes of France's Alpes Maritime. They are members of a small volunteer organization of young speleologists with the impressive title of the *Institut Francais de Speoleologie*.

From their headquarters in Nice, on the Cote d'Azur, they not only explore caves but, at the same time, offer their bodies to science as human guinea pigs. This group of young men and women, with some outside help, has brought off six daring and original scientific experiments since 1962. Chabert and Englander are the most recent.

The first four volunteers lived a total of 15 months isolated in the frigid darkness of caves. The four: Michel Siffre, leader of the group, dark, intense, 30-year-old geologist;

Josy Laures, blonde, attractive, 29-year-old nurse-midwife; Tony Senni, now 40, a cabinet maker; and Jean-Pierre Mairetet, 28, a mountaineer and designer.

Exploring caves is the group's hobby. But the experiments are deadly serious. They are studying people's biological clocks, or "circadian rhythms." Circadian, a word coined by Dr. Franz Halberg of the University of Minnesota, means "about a day" and was created to describe the literally hundreds of biological cycles of the human body: temperature, sleep-wakefulness, pulse, blood-pressure, brain waves—to name only a few—that fluctuate in patterns approximately 24 hours long. Although it is now certain that these rhythms regulate every aspect of our lives, science knows little more about them than that. Organized research in the field is only about 15 years old.

Yet as the human environment becomes increasingly detached from nature, knowledge and control of circadian rhythms becomes increasingly

It was as though they had been buried alive; five men and a woman—entombed in the echoing galleries of Alpine caves. But there was no comfort in their number. Each was sealed in alone to face the dark and cold in a place where time has no boundary. Why? To search for clues to the mysterious biological clocks that govern all life forms—"circadian rhythms."

vital. It is now commonplace to fly across six to 12 hours of time zones in a single "day." We all know that it takes time to adjust to the new clock hours. Why? How much time? These questions involve circadian rhythms, and the answers are linked with the safety of both crew and passengers. How much have the circadian rhythms of the crew been thrown off by the trip? What effect has it had on their reaction times?

And what of men isolated for weeks in ICBM silos, radar domes, nuclear-powered submarines? Such men carry enormous responsibility not only for their own safety but often for that of others. What happens to their eyesight, their time sense, their judgment in isolation? A missed radar blip, ■ too-slow (or over-quick) hand on ■ control, one color confused with another—any of these might spell disaster for nations.

Scientists in the U.S., England, France, Germany and the Soviet Union are studying such rhythms with great urgency. One way they do this is by putting people in isolation

chambers. Such experiments are called "free running" since the subjects do not know the time—hence their biological rhythms are freed.

The longest free-running experiment lasted one month until Michel Siffre confined himself in an Alpine cave for 63 days in 1962. It was the first time science had had a chance to study what happened to circadian rhythms for that long a period.

The most recent experiments, involving Chabert and Englander, lasted a total of 145 days. During the long months of solitude, neither man had any idea of the hour, the day or even the month—they had no clock, radio or time reference. And their companions on the surface, who constantly manned the other end of connecting telephones, took care not to give them any hint of time.

Each of the two men wore under his padded thermal clothing a strange set of nylon underwear of the type used by U.S. astronauts. The underwear carried 14 electrodes, which can be fixed to the skin, and a curved metal rectal thermometer—

all designed to transmit body temperatures, respiration, pulse and other data constantly to recording machinery on the surface. Each of the men had another six electrodes plastered to his temples, near his eyes and on his chin to check brain waves, eye movements and muscle tone—indices of the depth and stage of sleep.

Jacques Chabert's cave was constantly illuminated by electricity; he never escaped the light even inside his tent, for it was translucent. But Englender was able to control his lighting. He didn't know it at the time, but he kept the lights on for 36 hours at a stretch and stayed awake during that period—and then slept in darkness for 12 hours. He started doing this after his first two weeks underground. Thus, for him time shrank—he was living a “day” 48 hours long. However, he thought he was on a 24-hour schedule since he had no way of knowing otherwise.

‘Caves are free!’

Chabert, on the other hand, continued to live days much closer to the days above ground. His sleep-wakefulness rhythm recurred within periods about 24½ hours long.

Why conduct such experiments in the depths of caves? Michel Siffre, leader of the project, says, “We couldn't *afford* to build an isolation chamber. Caves are free!”

Funds were a problem from the very beginning of the project in 1962. Siffre, then an undergraduate geology student, did manage to get some backing from the French National Police and the Army—they were interested in the results. Most food, clothing and equipment, however, were borrowed.

On Monday, June 16, 1962, Siffre, then 23, entered a cave more than 300 feet below ground. His friends had set up a fabric tent on a wooden platform. In it was a cot, a bottle-gas cooking stove and a gasoline heater. His only light was a five-watt bulb powered by batteries.

Siffre was lonely, frightened, cold—so cold that his body thermometers registered one or two degrees (C) below normal. Every so often huge boulders would crash out of the ceiling, often close to his tent. He lay huddled inside two sleeping bags, dreading the next fall. At the end of what he counted as his first month, he wrote in his diary, “Interesting the effect different colors have on the mind. Red is agreeable; pink, restful; blue and green seem black.”

A huge hunk of ice crashed out of a crevice, almost hitting the tent. Fearful, Siffre started to get ready to sleep. He phoned the surface.

The man who answered said, “How much notice do you want when your two months are up?”

“About two days,” Siffre said.

“In that case, you can start getting ready tomorrow when you wake up.”

Siffre was dumbfounded. “You're not kidding?”

“No,” his friend said, “It's Friday, September 14.”

According to Siffre's reckoning, it was only August 20th. He had “lost” 25 days in 60 days underground.

In 1965, after much planning, two new circadian experiments were conducted. With the assistance of Dr. Franz Halberg of the University of Minnesota and Dr. Alain Reinberg, of the Rothschild Foundation in Paris, Siffre sent his wife Josy Lares and cabinet-maker Tony Senni down into separate caves—the

woman for three months, the man for four.

Underground, like Siffre, both quickly lost the sense of surface time. This confused Josy Laures about her menstrual cycle. She thought that she was menstruating every two weeks; actually, her normal period of 29 days shortened to about 26 days underground.

She finished her 88 days on March 11, 1965. Tony Senni emerged from his cave on April 5, after 126 days in isolation. Each was exhausted, but in good health.

The most important conclusion drawn from these experiments—up to that time the longest done on human beings—was that though temperature and pulse became desynchronized from clock time, they persisted in following a pattern of about 24½ hours even after three and four months outside of time. This fact was further proof of what had been mainly theory: that some essential bio-rhythms follow an internal circadian "clock." In the workaday world, they are "locked on" to the 24-hour day by such "synchronizers" as daylight and darkness, meal-times.

The Senni-Laures experiments confirmed some of the findings on Siffre—and posed new questions. What changes might take place over a longer time?

To find out, the next experiment would place one man, alone in a cave for six full months. The man: Jean-Pierre Mairtet, then 26, a strong, well-motivated mountaineer.

This time, the project had government financial support, and four of France's leading scientists collaborated in setting up tests: Prof. Michel Juvet, University of Lyon, on sleep-wakefulness and dreaming; Dr.



UPI

French "cavemen" (left to right) Philippe Engländer, Michel Siffre and Jacques Chabert wave after their 145-day stint inside cave.

Jean Colin, Army, temperature rhythms; Prof. Paul Fraisse, Sorbonne, psychological changes; Dr. Georges Perdriel, Army, visual perception.

On May 1, 1966, the tall, blond Mairtet dressed himself in waterproof arctic clothing and, with two escorts, entered a huge vaulted cavern more than 250 feet below the surface of the Alps. The darkness was nearly total. To get from one end of the chamber to the other, about 160 feet, they had to climb a small mountain of boulders which had tumbled from the ceiling. At the other side was Mairtet's tent.

As his escorts said goodbye, Mairtet could only stare at them wordlessly and think, *Six months alone! Can I stand it?* He threw himself on his cot and began writing in his journal. He didn't want to lose a single impression. And he worked out a calendar of 185 days, the length of his stay. He would mark off each "day" and not be fooled like the others. *If I can keep going for 100 days I can make it*, he thought.

Over the phone Mairtet would announce when he was going to sleep and when he woke up. He



UPI

Josy Laurés, 26, wears dark glasses to protect her eyes as she emerges from cave in Nice, France, after 88 days underground.

would be given tests, such as counting 120 seconds. On the surface, Marietet could count within a few seconds of a true two minutes. But in the cave his time sense shortened. Within ten days, he was taking more than 200 seconds to count to 120.

He would also take tests of his muscular force, respiratory rhythm and color perception. These were repeated at what Mairetet called "lunch" and "dinner." However, as his sense of time shrank, these meals might be 12 hours apart.

And he began to lose his memory. Above ground, he could repeat nine of ten words spoken to him; after a few weeks in the cave, he could reproduce only four or five.

Water dripped interminably on the roof of his tent, like the toll of a funeral drum. There were also the sounds of rockfalls and water rushing by; and they all echoed. Yet there was no movement. In a few days, Mairetet became sensitive to any movement: if a sheet of paper floated from the table, he jumped.

He began to get headaches. At first he attributed them to his "cooking" which consisted of mixing a few cans of food together into a pot. But he found out it was his light, a 40-watt bulb. It was too bright. He shaded it with red paper until it was only a dim glow. The headaches went away, and soon he found he could see in the dark, just by the spark of his cigarette. But his color-perception was off—he began to mistake green for blue.

About "10 weeks" after his descent, Mairetet woke from a deep sleep to find the cave being flooded. Water was already lapping the edge of his platform. If it rose much higher, he might have to swim for it, then dive for the tunnel and hope to find it in the darkness. But the tunnel was blocked by a wooden barricade!

For a minute or two he nearly panicked. Then he thought, *they won't let me drown*. If the water did not rise higher, he could manage. There was no danger of electrocution, as the voltage in his wires had been stepped down. But there was a threat he knew nothing about; lightning. A severe electrical storm was raging in the Alps. Knowing Mairetet was awake, the surface phoned him and told him to disconnect his electrodes. They did not explain why. Mairetet could not know it, but the flood in his cave was brought on by the same heavy rains that inundated Florence in the fall of 1966.

He didn't even know it was fall. On his 87th "day" he phoned to report that the water had subsided in the cave. "The experiment is over," someone on the outside said. Mairetet was convinced it was a joke—that there were still three months to go. But it was true. His 87th "day" un-

derground was really the 184th day of surface time, November 28, 1966.

From Mairtet's long immolation, scientists have accumulated a mountain of data never before available on a human being living without time references: 21.5 kilometers of electroencephalogram tracings, and equal kilometrage of records of his electrocardiogram, eye movements and muscle tone. There are 2,250,000 separate readings of his body temperature; thick volumes are filled with results of his perception tests, urinalyses and much more.

Not all of the data has been analyzed. However, Dr. Jean Colin and his group from the *Laboratoire de Médecine Aérospatiale* have reported on body temperature, which they think is basic to all circadian rhythms. Studying Mairtet's 2,250,000 temperature points, they found that his body temperature cycles fluctuated wildly in the free running environment. At the same time, the average length of his cycle increased progressively for three months. While his temperature curve had been a precise 24 hours on the surface, it lengthened to an average 24 hours and 47 minutes underground, before holding steady.

The average gap between the peaks of his free running cycles was two hours and 25 minutes. If this gap is the same in other people, say Colin and his colleagues, it may furnish for the first time a precise basis for calculating the number of days needed to re-synchronize a jet traveler. Thus, a Paris-Chicago traveller might need exactly three days (3 times 2 hours and 25 minutes) to make up the seven hour time difference between the two cities.

In the area of sleep, Professor

Jouvet thought that Mairtet might not be getting enough of the two essential types; deep, profound sleep, and light dreaming sleep. Without these, metabolism becomes disarranged and a man may show psychotic symptoms. But analyzing the electroencephalogram records, Jouvet could see that when Mairtet reported "I'm going to take a nap" he frequently slept for eight or ten hours—and got his needed sleep. In fact, during his first two months underground, Mairtet lived a day 48 hours long, averaging 34 hours of activity and 14 hours of sleep.

Help to astronauts

Mairtet's eating habits may also be instructive. He thought he was eating three meals a day. He would have breakfast and lunch, then a "nap." Then tea and dinner. But since his naps were long sleeps, he was in effect eating only two meals—one light, one heavy—during each waking period. His weight did not change in six months.

For months after he came out, Mairtet preferred to drive in the dark without even his parking lights. Only when he saw another car did he turn on his headlights, so he could be seen. And for a long time, he couldn't distinguish green from blue; orange appeared yellow, and yellow, white. Even the structure of his eyes changed in those months of darkness, but not irreversibly.

Says Siffre, "What we have learned from Mairtet will be useful to jet travellers, pilots, commandos, submarine personnel, night workers—but more important to astronauts." And, with a smile, "France, unfortunately, has no astronauts."



All photos UPI

This American soldier needs his wits to avoid sniper gunfire in Vietnam. For many of his buddies, relief from such tension and overpowering boredom is achieved with Vietcong marijuana.

The Vietcong's secret weapon: marijuana

Merchants, street walkers, and even the children peddle drugs right in the square. It's Vietcong marijuana, laced with opium, and it's becoming a constant threat to the American soldier.

by Arturo F. Gonzalez Jr.

WHILE the Paris peace talks drone on, and the thunder of artillery and machine gun fire trickles down to a desultory now-and-then sniper's shot or quick fire fight, the Vietcong is staging a new and subtle attack on the American fighting man.

The VC's secret weapon: *Cannabis sativa*. More commonly known as marijuana.

"This is the first war in which the Army has been more concerned with marijuana than with V.D.," says psychiatrist Dr. John A. Talbott, who just returned to the U.S. after a year in South Vietnam with the Army Medical Corps.

He reports an increasingly high incidence of psychotic reactions among servicemen after smoking Vietnamese marijuana—probably because of opiate additives present in the Vietnamese product.

The Pentagon is seriously alarmed not only because of the psychological consequences but also because they know that money spent on the drug is being funneled right back into the hands of the Vietcong.

Says U.S. Navy Rear Admiral James Kelly flatly, "Our commanders have evidence that the Vietcong and North Vietnamese have large stocks of the drug in the vicinity of our troops in an effort to subvert them."

The mere mention of *con xa* (Vietnamese jargon for marijuana) brings an instant look of recognition from Vietnamese taxi drivers, sidewalk vendors and even children playing in the streets. Usually, the marijuana is sold in cigarette form, already rolled, in cellophane packets of 10. The cost is dirt cheap—ranging from \$1.00 to \$2.50. In Saigon, packets are purchased openly on any cigarette stand on the Tu Do—the city's main street in the heart of the downtown area.

Da Nang-based servicemen pick up their junk at China Beach near the USO. At Cam Ranh Bay, the site of a major U.S. logistics supply area, almost every bar in the village is selling marijuana for the asking. At Chau Doc, not far from the Cambodian border, four ounces of marijuana sells for about \$4.25 while a kilogram can be purchased for just under \$34.

The GI is exposed to marijuana from the very moment he lands at Saigon's Tan Son Nhut airfield. Little Vietnamese beer stands set up in the rear of the base fill all orders. Sold in what looks like an ordinary pack of regular American cigarettes, the marijuana has been neatly packed into what once were American brand packs. Only a small piece of Scotch

tape near the bottom of the pack indicates that the tobacco cigarettes have been replaced by reefers. One alley lined by brothels near the base is also a marijuana den. Says one trooper, "There's so much marijuana in that alley that if it ever caught fire, it would *stone out* all of Saigon."

Government officials are usually loath to talk about the problem. One 1966 Joint United States Public Affairs Office press release underestimated the situation, stating "One soldier in 2,000 has been found to possess or use marijuana." Slowly since then the brass has begun to admit that the problem is bigger than this. Figures for 1967 over 1966 show an *increase* of marijuana-smoking reaching 62 percent. And this figure reflects only officially investigated cases and does not cover the tens of thousands of GIs who are smoking but have not been caught. The Defense Department announced in January that nearly nine out of 10 young soldiers court-martialed for military offenses in Vietnam had

Stores cater to GIs in Saigon, so do bars, sidewalk vendors and call girls. Most such shops are well-supplied with *con xa*, marijuana.





An American in civilian clothes makes a purchase at a sidewalk stall in Saigon. Most such shops deal in black market goods.

smoked marijuana before they joined the service. Continuing their habit became quite easy when they reached the streets of Saigon.

"There is just no way of really telling how many men have used drugs," says Colonel Everett G. Hopson, an Air Force officer involved in investigating narcotics. "If I were to hazard a figure it could be as high as 15 to 20 percent. That is the figure experts use when they talk about how many high school and college

students have tried some kind of drug, and those are the people we pull into the service."

John Steinbeck Jr., son of the late author, stirred up a Pentagon hornet's nest when he returned from Vietnam to say that 60 percent of the GIs "turned on" and that he had "direct experience" with about 350 marijuana users in the military including "a great number of military police and legal officers."

Another major problem is that the GI smokers, after their year's tour is up, are trying to bring marijuana back into the States with them. A record 26,000 pounds of the drug has been seized from GIs in the last fiscal year—twice as much as during the previous 12 months.

Admits Colonel Hopson, "A soldier leaving Vietnam may have his baggage carefully screened without his knowing it." About 50 German shepherd dogs have been trained at Fort Gordon, Ga., to recognize the scent of marijuana. The dogs sniff the stuff even when its concealed in duffle bags or carefully wrapped. Another drug sensor is a small X ray spotting device which can "look into" suitcases and boxes searching for marijuana.

The VC are so clever that for ■ time some GI prisoners at the LBJ—the Long Binh Jail, the GI name for the Army stockade—were actually getting marijuana even though behind bars. The junk was being slipped in from the outside through "trusties." A stockade officer accidentally picked up a pack of cigarettes from a desk one day, lit one, and found he was smoking marijuana. The pack probably had been dumped by a frightened guard.

In Cam Lo, just south of the

DMZ, infantrymen get pot from children who live in the refugee camp there. Sharp Vietnamese kids at Da Nang make money by double-crossing U.S. Marines. They peddle a few joints to a trusting trooper, then double time to the nearest MP and collect a reward for reporting that the Marine has junk in his possession.

An increasingly common practice is to lace the marijuana with opium; this gives a higher high. "You'll put both legs around the rafters when you smoke one of these," says one CID investigator. It is such opiate additives that have psychiatrists worried about pot-smokers in Vietnam.

The opium trade is almost as active as the marijuana business. Vietnam has long been one of the major way stations in the world's opium traffic. The poppies come out of Laos, Northern Thailand, Burma and Red China through Vietnam on their way to the Western World. Tons of opium pass through Saigon every year. Rumors have long had it that Saigon government officials are working with the VC to make illegal fortunes in this opium traffic.

A major Pentagon problem is that since a GI figures he's breaking the law by smoking pot, he becomes a law breaker in other ways as well. Many deserters in Saigon live comfortably by selling marijuana and opium to American servicemen. Marijuana income long supported the "Home of Lonely Hearts" on Cong Ly Street, which appeared to be just a booking office for Saigon's call girls but was actually part of an extensive criminal network that furnished American deserters with everything they needed, from forged identification papers to pistols.

Is pot smoking confined to the rear areas or is it done in the battlefield? Major Robert Donovan, Assistant Provost Marshall of the First Air Cav. Division, believes few troops smoke in the field because the GIs have a strong sense of loyalty to other soldiers they're with and they're afraid of what people will think."

Adds one Marine Sergeant, "Out in the field we never smoke, but here in our barracks we're smoking all the time. I'd say half the guys in this town smoke grass a lot."

'Pot' relieves the boredom

On the other hand, one Saigon-based newsman recently reported spending a night with a Fourth Infantry Division patrol in the central highlands during which ten soldiers wiled away the evening in their tent by smoking pot. A First Air Cav. Division doctor says medical men occasionally see wounded soldiers in clearing stations whom they suspect may be high on pot. One group of soldiers whose job is to escort dead bodies from the field into the mortuaries at Saigon and Da Nang told a reporter recently that they were taking marijuana from four out of every five American dead during Tet. "We took a pack of Camels off a lieutenant," they said. "It turned out to be full of joints."

GIs in Vietnam apparently smoke pot for the same reasons that college students in the States turn on: to relieve tension and boredom, because they are looking for a kick and as a means of rebelling against authority. Many pot smokers are among the most intelligent members of the regiment. Says Colonel Douglas Lindsey,

a medic, "Soldiers who smoke pot are more likely to be found among the better soldiers in the unit."

Officially, the government takes a hard line on marijuana. Raids are frequent. CID men posing as GIs in search of a smoke constantly try to seek out VC suppliers. MPs and Vietnamese cops frequently stage joint raids on suspected cellars and bars. When GI bar patrons see a raid coming, they dump the contents of their pockets on the floor. The sweepings after one recent raid produced about 30 joints.

Enemy is the big pusher

The main reason behind this hard line is that Army authorities agree that it's a good source of income for the VC and reduces the effectiveness of the U.S. troops. "The enemy is the big pusher," warns ■ First Cav. officer. "The use of marijuana in Vietnam not only endangers the life of the user but also the lives of those depending upon him for the successful accomplishment of his mission."

The Army feels the marijuana user is as dangerous behind the wheel of a car as a drunk. In Vietnam, where any trooper can get his hands on a weapon and ammunition easily, anything that affects his judgment can be dangerous. "Marijuana and gun powder don't mix," says one officer.

As evidence, authorities point to an incident at Cu Chi which was being hit by Vietcong rockets. Two troopers, high on maryjane, became so enchanted with the fireworks that they sat on the sandbag wall to watch. A round landed ■ few yards away, killing one of the soldiers and wounding the other. In another case,

two airmen at Tan Son Nhut were killed while passing a hand grenade back and forth with the pin pulled. The men were high on pot.

Although the Pentagon insists it is holding to ■ hard line against marijuana, in the ranks, there's a great deal of permissiveness. Some GIs say their officers and NCOs know there is pot in the outfit but don't turn in smokers, especially in combat outfits. "If a guy's been on the line ■ while and is experienced," says one sergeant, "why should the company commander turn him in for smoking a little pot? He's going to lose ■ good man and get a green replacement." The strong bonds of loyalty and friendship which grow between men in units who face combat together can often make a line officer or NCO reluctant to turn a pot-smoking trooper over to the MPs. "We've talked to some kids who smoked marijuana and we haven't prosecuted them," says one legal officer, "because we were convinced they tried it only once and didn't use it regularly. Almost every college kid in the U.S. is experimenting with pot. We can't expect our soldiers not to."

It adds up to a major dilemma. The soft-liners, inside the military and out, say that marijuana is less harmful than liquor or tobacco and shouldn't be illegal.

Hard-liners answer that drugs are harmful and should be controlled even if it means handing out bad conduct discharges and five years' hard labor in jail—the maximum sentence for drug offenses.

And all the time, Victor Charlie's getting rich on the proceeds, possibly beating with marijuana cigarettes those American GIs whom he hasn't been able to defeat with gun powder.



Parakeet flies at simulated speeds of up to 30 mph but never moves a distance of more than several feet. Face mask is attached to measure amount of oxygen breathed in and carbon dioxide breathed out for "fuel" consumption.

Birds that fly nowhere

by Don Seaver

TEACHING A BIRD to fly might seem like teaching a fish to swim—but not when the bird is going to wear a plastic air-supply mask, fly 30 miles an hour for several hours and not move more than a foot or two.

That is what Dr. Vance A. Tucker, ■ Duke University scientist, has taught birds to do in an attempt to learn more about the fuel requirements and aerodynamic characteristics of what are still, in some ways, the world's most efficient flying machines—our fine feathered friends.

One of the classic problems in measuring bird flight characteristics is that flight requires the rapid movement of air past wings. With birds flying past an observer, it has been

difficult to make meaningful measurements.

Tucker's solution to this problem was to place birds in a wind tunnel so that the air would move past them while the animal essentially was standing still. If the tunnel air-speed is set at 30 miles per hour, then the bird will expend the energy required to fly at that rate while really not moving forward.

Starting with parakeets and an eight-foot-long wind tunnel, Tucker found that these small and colorful birds could be taught to fly in the tunnel by charging the floor and walls with a weak electric charge.

"The shock is too weak to be painful," he says. "It's just a way of signaling the birds. If you hurt them, then you might as well give up trying to train them.

The parakeets learned that by flying in the tunnel they could avoid the shock. They soon learned by experience not to bump into the walls.

To actually measure fuel consumption in flight, the Duke scientist taught his birds to wear a transparent plastic air mask with which he can measure the amount of oxygen breathed in and the carbon dioxide breathed out.

From the relative exchange rates of these gases, the energy released from chemical compounds within the birds' bodies can be worked out. According to Tucker, a useful measure of the effort of flying is the amount of fuel a bird or aircraft uses each hour expressed as a percentage of total weight.

"Using this measure," he says, "budgerigars (parakeets) are more economical fliers than most insects and man-made aircraft."

Parakeets use one percent of their body weight for fuel each hour that they fly at a speed where power expenditure is at its least. Man-made aircraft use between two and 36 percent. One migrating insect, the desert locust, uses less than one percent but other insects investigated use seven to 35 percent.

Since he has found that parakeets primarily use fat as fuel for flight, he can use the one percent figure to work out a rough estimate of how long a bird can keep flying. Some migratory birds store up to 50 percent fat, suggesting they can fly non-stop for at least 50 hours.

"We don't build floppy winged aircraft," Tucker says, "so we know relatively little about their power requirements. We hope to describe the energy costs of flight for different birds and find out how much fuel it

takes them to fly a given distance."

He also points out that little is known about the aerodynamic characteristics of floppy-winged flight. Using fast-action pictures and a computerized setup, studies are under way to determine such things as the exact position and conformation of wings during various aspects of flight.

Another subtle mystery about migratory birds is how they find their way back to the same place year after year, a navigational feat often involving many hundreds of miles.

A colleague of Tucker's, Dennis McDonald, is working on the theory that birds are able to calculate direction by the angle of the sun.

The theory is being tested by placing birds in the wind tunnel with a light and teaching them that by carrying out certain maneuvers they can change the position of the light to make it conform with a flight path they have been trained to take.

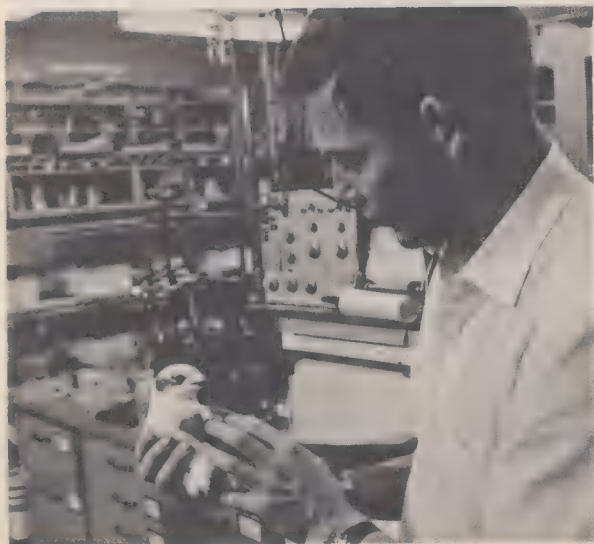
Tucker notes that many questions remain about bird flight. How can birds perform the strenuous exercises of flying at altitudes of 20,000 feet or more where man can hardly move because of lack of oxygen? What do birds see or sense while flying that enables them to navigate over unfamiliar territory?

Thus far, some birds have flown for as long as 10 hours in the new 25-foot wind tunnel with its four-by-six-foot flying chamber, and Tucker believes that these experiments may soon open many doors.

"These investigations show that it is feasible to make measurements on birds flying under controlled conditions. They provide the hope that in the next few years, we will be able to answer some of the many questions about bird flight."



Dr. Vance A Tucker has found that gulls learn to fly in the wind tunnel much faster than parakeets. It takes a month to train a parakeet while it takes only four hours for a gull.



NEW FOR PEOPLE

Saucer hydroplane (below), is steered by shifting body weight and can reach top speed of 40 mph, and is a new import from England. Called the Circraft, the circular boat is made of reinforced fiberglass, has no rudder, measures seven feet in diameter, will use 15 to 35 hp engines and can accommodate maximum of four people in an emergency, but is best suited for one or two. Manufactured by Bifort Engineering Ltd., Preston New Road, Blackpool, Lancashire, England.



Computerizing heart patients (right) is being done today at Mount Sinai Hospital in Manhattan. An ECG (electrocardiograph) is used to trace the heart-beat of the patient. It is linked to telephone handset and signals sent by acoustical coupling to be recorded on magnetic tape. IBM 1827 converter apparatus prepares tape for playback and specialists analyze results. Recording is converted into digit code in the IBM 360 system. Medical experts then compare their interpretations of ECG with the computer findings.

Three Lions



Pictorial Parade

Cambridge Page-turner (above) automatically turns book or magazine pages for paraplegics or polio victims. Cambridge Consultants Ltd., Cambridge, England, invented the device and showed it at the London International Inventions and New Products Exhibition held earlier this year in Westminster, London.





Three Lions

PET (Portable Executive Phone) is the first wireless, fully portable phone. To use PET, one must push a row of 11 buttons to find open channel. Next he must hold down transmission switch on handset until mobile operator accepts his call, which is then completed over regular telephone lines. Incoming calls are announced by a buzzer and light. Federal Communications Commission license is required to operate PET. Manufactured by Portatronic Systems Inc., 60 East 54th St., New York, New York.

Spray-foamed plastic chair (below) created by John C. Widener, plastics specialist for the Smithsonian Institution, is made of low-density polyurethane foam usually used for insulation and more recently by Yale architecture students for experimental housing (*Science Digest*, Feb. '69). Basic material is not resilient, but addition of softer foam coating to rigid core would increase chair's comfort and sprayed plastic skin would protect surface. "Biltfoam" from Biltton Insulation Co., Arlington, Va.



Can your color TV stand a radiation count?

That "bargain" secondhand color TV set you're thinking of buying may be more of a danger than a bargain. Some reconditioned sets are showing seriously high radiation counts.

by Grace Weinstein

IN OCTOBER OF 1967, a businessman in Florida phoned his wife with some good news. They had been planning on buying a new black-and-white television set, but he had just located a real bargain. It was a reconditioned *color* model with a large screen, which he could have for only a few dollars more than they had planned on paying for a set without color. The deal was made, and he and his wife and their

two children began spending many enjoyable hours of watching.

Some two months later, though, an incident took place which came as a considerable shock. A survey of color television sets in the area was taken throughout December and the first half of January 1968, by the Pinellas County Health Department. The "bargain" set was found to be emitting almost 100 times as much radiation as was considered safe. It is easy to understand the concern of the parents, who thought about the





hours on end during the preceding weeks that their children had spent with their eyes glued to the screen. Worse still, they learned that there was no immediate way of determining whether the radiation exposure had caused any tissue damage that would lead to trouble later.

Unfortunately, this is not an isolated case. In a hearing before the Subcommittee on Public Health and Welfare in February 1968, it was brought out that 16 percent of the 110 color TV sets examined were

emitting too much radiation. In similar tests of 1,124 color TV receivers in the Washington, D.C. area, made by the National Center for Radiological Health, 268 were found to be emitting X radiation, and nearly six percent exceeded the recommended emission standard. Thus far, such studies have been few and scattered, but the findings have been similar. In Suffolk County, nearly 20 percent of 900 sets tested emitted too much radiation; and in Dade County, Fla., the figure was 12 percent. In many

cases, the amounts of radiation were small and relatively harmless, yet there were enough serious overages to cause concern. In the Washington study, for example, one set was found to be emitting more than 700 times the acceptable level.

Just what is radiation and how does it affect the body?

The kind most familiar is that caused by the sun or a sunlamp. Tiny particles so small they cannot be seen on a microscope, called photons, travel at incredibly high speeds from the source, vibrating and bombarding whatever they hit. Photons from a sunlamp penetrate the skin and give it a tan or a sunburn, depending upon the intensity and length of exposure. X rays, which are basically the same, but enormously intensified when they are created through the bombardment of a metal plate by high-energy electrons in a vacuum tube, can be highly dangerous. They are deeply penetrating and will disintegrate tissue completely, which is why they have been used to kill cancer cells. The radiation from a defective color TV set acts in effect like an X ray—ininitely milder, but potentially dangerous if the level is high and the exposure continues over a long period.

Almost any high-voltage vacuum tube produces some X rays, the intensity depending directly upon the power. Black-and-white TV sets pose no problem because they function on relatively low voltage. Color receivers, however, must contain many tubes that operate at a high enough voltage to cause radiation. Normally, this radiation never penetrates beyond the walls of the set itself. The glass tube is thick enough to form an

effective screen, and manufacturers provide additional shielding to protect the viewers. The danger occurs when there is a defective component which either increases the voltage far beyond what the manufacturer intended, or when the set has been tampered with in such a way that the shielding is not complete.

In the case of the "reconditioned bargain" bought by the Florida family, the job was done by an amateur who "beefed up" the voltage and who inadvertently forgot to replace an important inner shield. As experts testified at the Subcommittee hearings, any repairman can adjust the energy level, and so can many a do-it-yourself tinkerer at home. Not all of them know what they are doing.

Kids climb on sets

Radiation moves in a direct line, and thus there is almost no danger—even in a defective set—for someone sitting squarely in front, where the glass in the tube and on the panel protect the viewer. And radiation dissipates quickly with distance, so that once again there is little danger for a viewer seated six feet or more from the screen. The concern arises because of the viewing habits of children, who invariably like to get as close as they can to the action and who frequently "climb" on the set, so that they could be exposed to radiation leakage from the sides, if the shielding is defective or missing.

According to a New York City radiologist, Edward E. Sheldon, M.D., even mild doses of X rays can lead to the early development of cataracts in the eyes, which face the TV set with no protection at all for any

The amount of radiation damage often cannot be determined until it is too late.

viewer not wearing glasses. Combine this factor with a defective TV set and a recent estimate and you could have trouble. The estimate, published in the July 1968 issue of *Kiplinger Magazine*, stated that the average child spends more time in front of the TV screen than he does in class—some 15,000 hours by the time he has finished high school.

Because radiation is produced whenever a beam of electrons strikes material at a high velocity, as in a vacuum tube, there are three potential sources in a color TV receiver: the picture tube itself; the high-voltage power supply (which is easily increased above normal if there is tampering or a defect); and the shunt regulator tube, which helps to control the power supply. It was noted in one report that if the power were to be boosted a mere five volts in one faulty set, the radiation would have been multiplied to 200,000 times the accepted level!

How hazardous is radiation?

There are two types of damage that can occur. The first is *somatic*, which directly affects the person exposed and which may not be detectable until it is too late to take corrective measures. This is a breakdown of tissues which, much like a severe sunburn, is not even noticed until some time after the damage is done. The second type, much more insidious and about which very little is known, is *genetic*. Radiation can affect the genes and unknowingly be passed along to future generations. A study of 450,000 infants conducted by the Harvard School of Public Health noted that there was an increase of 10 to 30 percent of cancer in children whose mothers

had been irradiated in the course of pregnancy.

That is not to say that the radiation from even a very faulty TV set will be strong enough to have similar effects. Yet, because they know so little about the problem, specialists in the radiological field stress *caution* as the only sensible attitude to take. They point out that it is difficult, if not impossible, for physicians to detect the immediate physiological effects of radiation, even in cases of strong exposure. And, as the hearings brought out in Washington, there is even controversy over the methods and reliability of testing TV sets, to determine how much radiation is being emitted.

For this reason, you should be wary of advertisements which offer gadgets for testing the radiation in your set, or elsewhere. Most of them are useless. And even the most expensive Geiger counters, or similar instruments, are accurate only when used by well trained and qualified technicians. There is only partial agreement, too, as to what levels of radiation are "safe." The National Council on Radiation Protection and Measurements recommends that radiation levels for TV sets should not exceed 0.5 milliroentgen per hour at a distance of five centimeters (about two inches) from the set's surface. This is ultraconservative, yet most television receiver manufacturers use this as a standard and stay well within the limits.

In the past, not enough attention was paid to engineering sets so that the shielding was tinker-proof. But current receivers are being manufactured with every conceivable built-in safety feature. As one medical direc-

tor of a company engaged in manufacturing color sets expressed it, "Color and black-and-white television sets made by us more than satisfy all the safety requirements of the National Council on Radiation Protection Measurements. . . ."

Your only concern should be to have your color TV set thoroughly inspected and adjusted by a reputa-

ble repair service *if* you have an older model, have bought one second-hand or have any suspicion that the workings have been tinkered with by someone inexperienced or unqualified. Other than that, keep your children (or *try* to) six feet from the set while it is on.

With these precautions, you need have no cause for alarm.

COLOR TV SETS—DO'S AND DON'T'S

1 Don't buy secondhand color TV sets, unless you are certain that the dealer is both reputable and knowledgeable and will guarantee that the set has been thoroughly inspected and adjusted.

2 Don't buy color TV sets from friends or other private sellers without having the set thoroughly inspected, tested and adjusted by an expert repairman.

3 Have the voltage regulator checked at regular intervals. This must be kept at the level specified by the manufacturer, and should never be adjusted by an amateur or do-it-yourselfer, even if such adjustment seems to improve the picture quality.

4 Never open the back of the set, or poke around with controls other than the ones obviously intended for the viewer's use.

5 If you own an older set, have it checked out completely, and ask the dealer or manufacturer's representative whether the shielding is in place and adequate. (In some of the older sets, secondary shielding can too easily be removed during repair, and in some cases may not even have been put back in place.)

6 Don't continue to use a set that is acting up. Some are purposely designed so that the image becomes poor once the voltage is too high or safety features become defective.

7 Insist that viewers, particularly children, sit back from six to ten feet from the image.

8 Make sure that viewers sit in *front* of the set and not too much to the side; and do not let anyone who is not viewing sit alongside the set. (If there *is* radiation, it is more likely to emanate from the sides than from the front, which has a natural shield in the form of the glass itself.)

9 Be wary of buying handy "Geiger Counters" or other testing devices for radiation, which are advertised as being usable by anyone who owns a set. Even the experts do not agree on the devices or methods to be used for effective testing.

If you observe these simple precautions, no matter what make set you have, you need not be alarmed by the scare headlines.

The disappearing toad

The spadefoot toad can dig his way backwards into the ground and disappear in only three or four seconds.

by Robert H. Wright

FROGS AND TOADS have long been associated with magic and witchcraft, and it's easy to understand why once you've made your first encounter with a spadefoot toad. There isn't any magic involved, but keeping track of the little amphibian is hard. One second the spadefoot is sitting on the ground, and a few seconds later he is *in* the ground—completely buried.

A spadefoot does his disappearing act simply by wiggling his hind quarters; he literally sinks into the ground. If the soil is loose, the toad can accomplish this in only three or four seconds. Even more amazing is the fact that he can remain buried in the ground for months.

There is nothing magical, however, about the way he accomplishes this feat. A good look at his hind legs reveals that he has the essential tool of any digger—a spade. In fact,

he has two of them, one on each foot. These spades are tough, horny projections that scrape the soil away, leaving a hole that the toad's plump body quickly fills.

The amphibian remains buried all winter, and when spring comes, he digs his way up to the surface. But even when the spadefoot is up on the surface, finding him is extremely difficult. Unless he moves, he may easily be mistaken for a clod of dirt. His brown and yellowish-gray coloring camouflages him almost perfectly.

People often wonder whether the spadefoot is really a toad or a frog. He has the smooth skin of a frog, rather than the rough warty skin of a toad. But since he lives most of his life on land, he is called a toad. Scientifically, he is a member of the family Pelobatidae and genus *Scaphiopus* of which there are four species in the United States.

Turn the page for a close look at the spadefoot's act.

Looking more like a frog than a toad, the spadefoot has smooth skin instead of the rough, warty skin of a toad. He lives most of his life on land, so he's a toad.

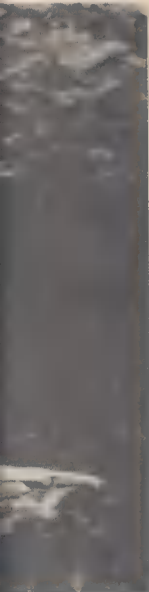




The tools of the spadefoot's disappearing act can be clearly seen above. This swimming spadefoot shows his hard, black spades on his hind feet. With these structures he is able to dig holes in the soil in which he may spend several months.

In a "going-going-gone" action that sometimes takes only a few seconds the spadefoot buries himself for the long winter. When spring comes, he just reverses the process. Even in his position below he is able to catch insects with swift precision.





In a twisting, wiggling motion the toad begins to dig his way into the soft earth. The amphibian is almost perfectly camouflaged so that even when he is not buried he is difficult to spot. Above, he has just begun to dig his underground home.

Just one alert eye shows through the surface of the ground where this spadefoot has just completed his disappearing act. He belongs to the family Pelobatidae and though called a toad, he is not a true one. They belong to the Bufonidae family.



Science Month



The men who will pilot LEM to moon's surface will probably be Apollo 11 crewmen Edwin E. Aldrin Jr. (left) and Neil A. Armstrong (center), shown with third crewman Michael Collins.

Two for the moon

THE MOST INTENT observers of Apollo 10's lunar orbit this May will be the two men who expect to spend a day on the moon in July. If all goes well with Apollo 10, Neil A. Armstrong, a civilian, and Col. Edwin E. Aldrin Jr., of the Air Force, will leave Apollo 11 and drop to the moon's pockmarked surface aboard the Lunar Excursion Module (LEM). The third crew member, Air Force Col. Michael Collins, will remain aboard the orbiting Apollo until his colleagues return.

The two explorers are slated to spend 21 hours on the surface, three of them outside the LEM. They'll set out instruments, take photographs and pick up samples of rock. Then

it's back to Apollo 11 for the return trip of some 78 hours—20 hours longer than it took Apollo 8 to cover the same distance in December. The earlier craft could hold more fuel because it was not carrying the 16-ton LEM.

The Apollo 10 mission should give Armstrong and Aldrin a fairly good idea of what they'll see on the moon. The LEM will descend to within 10 miles of the lunar surface on reconnoitering orbits. Unlike the Apollo 11 LEM, the one on Apollo 10 isn't capable of landing and taking off. Otherwise, the "moon bugs" are identical. Spindly-legged, 23 feet tall with octagonal body and bristling antennae, it resembles an enormous in-

sect. Its two main sections are each powered by an engine, one for ascent and one for descent.

A slight chance exists that LEM No. 5 *might* be substituted for No. 4 so that the May mission could become the first on the moon.

The lunar modules, both manufactured by Grumman Aircraft, work like this: The crew members enter the LEM through a hatch in the Apollo. They separate from the spaceship and descend to the moon, powered by a 10,000-pound-thrust descent engine. Then, with astronauts back aboard after their walk, the less powerful ascent engine will blast off under 3,500 pounds of thrust. The LEM will climb back to its orbiting mother ship, dock, and the moon voyagers will rejoin their colleague. The LEM will be detached, to orbit the moon until it eventually crashes on the surface, while the Apollo fires up and heads earthward.

Coming up on the space calendar are at least two more lunar landings from Apollo 12 in the early fall, and Apollo 13 in the winter. The Apollo program has enough Saturn V rockets stockpiled to boost still more spacecrafts into a moon orbit. What happens after that is spelled out in the article on page 42.

The cost of the Apollo program? About \$24 billion, most of it already spent.

Sea cow in Loch Ness?

The Loch Ness monster might be—hold on now—an extinct sea cow! Steller's sea cow, to be exact, an animal measuring up to 35 feet long that was killed off in recent times for



Lunar Module will separate from Apollo command module as shown (top). On moon's surface, this array of reflectors (bottom) will serve as target for earth-based lasers to measure such phenomena as continental drift.



fur and food. The sea cow theory is advanced by the Loch Ness Phenomena Investigation Bureau, which maintains a year-round watch on the lake in the Scottish highlands. How did a sea cow get in the landlocked lake? After the last icecaps retreated

5,000 to 7,000 years ago, goes the explanation, many lakes were cut off from the sea. A large aquatic animal trapped in the new lake would have been forced to adapt or die. The Loch Ness Bureau had one interesting piece of recent evidence: ■ 13-minute sonar sequence that shows objects too fast and too big to be schools of fish moving in the depths of the 700-foot-deep lake.

Lasers chart nerve paths

A scientist at Bell Telephone Laboratories is irradiating the nerve fibers of ■ large snail with lasers to

This specimen of *Aplysia californica*, a big marine snail, doesn't know it but it may tell us a lot about the human nervous system. Richard L. Fork of Bell Telephone Laboratories, irradiates the creature's nerve fibers with a laser beam to stimulate cells without damaging them. The experiment provides clues to the connections of nerve cells.



find out how nerves send impulses to the brain. Richard L. Fork has discovered a way to stimulate certain nerve cells of *Aplysia californica* with lasers without damaging them. Apparently the beam affects the cells in two ways: (1) it increases the conductance through the cell membrane of ions that travel in and out of nerve cells and (2) it increases the action of the pumping system that maintains the balance of ion concentration necessary for the cell's functioning. Human nerve cells show similar conductance changes when they generate nerve impulses.

Living stone age Americans

Sixty or 70 individuals living deep in the Surinam jungle of South America may be the most primitive people left in the New World. Remnants of the "Wama," they were contacted last summer by a party of missionaries. It had been 30 years since they were last seen. They may never be seen again.

"An inexperienced person endeavoring to contact this tribe would place his life in jeopardy and no doubt cause them to disappear again into the deep interior," says Ivan L. Schoen, one of five missionaries who spent a day and night with the Wama last summer.

According to Mr. Schoen, whose experiences are described in *Natural History*, the Wama are stone age people. Their axes are crude; their pottery thick, heavy and without design. They show skill in making bows, which are well turned and smoothed with a boar's tooth. Arrows are tipped with curare, a deadly poison extracted from a native vine.



They eat meat, fish, fruit, a few nuts, honey and heart of the *Mauritia* palm. They refused bananas, sugar cane and cassava bread offered to them. One old Wama slipped his bread underneath him and sat on it. None would give his name, and before the missionaries had spent the night, they were told to go in the morning. Since the Wama kept their weapons nearby, the missionaries departed promptly.

Death and geography

More people are dying in England's beautiful lake country than down along the southeastern beaches, and no one knows why! A startling and inexplicable variation in death rates in different parts of Britain was reported recently by the National Health Service in *New Scientist*, a British publication. Mortality is well above average in the north and west,

It will never win a beauty prize, but it looks like Old Guy, London Zoo's gorilla. How do you sculpt a gorilla? J. Parker used a photograph and Guy's dimensions to make a clay model. He prepared a two-piece plaster mold of the model, coated it with a release agent, then wired the pieces together. When a coat of Araldite resin was applied, the plaster could be chipped away.



below average in the south and east, with some exceptions in London.

The unhealthiest part of Britain apparently is the Mersy-side-South Lancashire area, where mortality runs between 24 and 22 percent above the national average. South Wales is another unfavorable spot.

London, being in southeast England, is not in an area characterized by high mortality, but four of its boroughs (Southwark, Stepney, Shoreditch, St. Marylebone) record death rates comparable to those in the northwest. Other boroughs are *below* the national average—by 17 percent in Hampstead.

Glasgow, Scotland, records a similarly puzzling pattern. As a whole, the city has a mortality rate for coronary disease that is 25 percent above the national average.

One possible factor in the local variations may be water supply, according to the report. Glasgow has a soft water supply and a high rate of cardiovascular disease while London, with a hard water supply, shows a much lower rate of heart disease. Mortality variations within the cities may be linked to the fact that both London and Glasgow get their water from a number of different sources.

Parrot problems

For every live South American parrot sold in U.S. pet shops, an estimated 50 parrots have died, says a recent Public Health Service report on the subject. Some birds are killed by rough handling in collection, others die in cages along tropical riverbanks as they await purchase by exporters, still others perish en route to the U.S. A parrot brings only a few

cents to the Indian collector, but as much as \$50 here since the ban on importation was lifted in 1967. Fear of parrot fever (psittacosis) had kept the birds out of the country, but now antibiotic treatment enables healthy birds to be imported. Last year, 10,000 were imported—and half a million may have died.

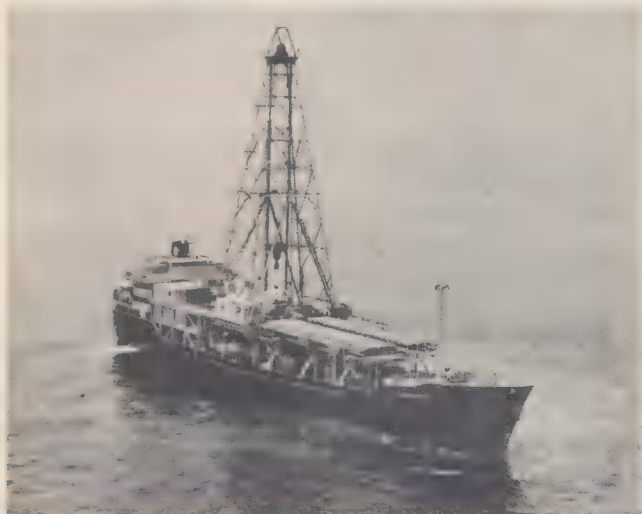
Movies from way back

The best seat in most movie theaters today is back where the popcorn stand is, claims research scientist Petro Vlahos of the Research Center of the Association of Motion Picture and Television Producers. Tests with wide-screen films show that most people prefer to sit between four and seven picture widths from the screen. With larger screens, this puts the favored seats out in the lobby. A properly functioning TV set, says Vlahos, offers a better picture than many theaters provide.

Another Pompeii?

The houses of a city buried by a volcano some 3,500 years ago are being unearthed by Greek archaeologists on the Aegean island of Thera. According to Professor Spyridon Marinatos, chief of the Greek Archaeological Service, the residents had time to flee the city only with their most valuable and portable possessions, leaving behind such items as jars of snails and barley flour, a set of lead weights, pottery and a clay medicine chest. Thera, about 70 miles north of Crete, is believed to have been settled by Minoans from Crete in the second millenium before the Christian era.

The new Time machine



The *Glomar Challenger* is diesel-electric powered, 400 feet in length and has a beam of 65 feet and a 20-foot draft. Drilling derrick is 142 feet high.

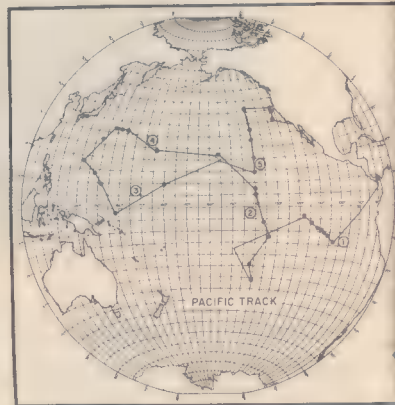
The natural archive of the sea may soon yield the secrets of the prehistoric past. With a coring apparatus on the *Glomar Challenger*, scientists are drilling down through millions of years of unknown geologic history.

A EONS BEFORE MAN was capable of composing a history of himself in language, a coded diary of the geological and chemical miracle of life on this planet was being compiled by the sea. While millions of years passed, an endless rain of minute particles—flecks of earth, eroded rock and volcanic ash carried far from land by the sweep of the wind and the offshore currents, and

the microscopic remains of the tiniest creatures dwelling in the sea—steadily drifted down to the ocean floor. At a rate as slow in some places as a few millimeters every thousand years, a mosaic depicting the epic climatic changes and violent physical upheavals which have structured our world was being pieced together in the sediment settling on the bottom of the sea.



Glomar Challenger is equipped with a computerized system for maintaining an exact position during the coring process. The arrows fore and aft indicate the forces exerted by propulsion units which respond to acoustic beacons stationed on ocean floor directly below the drill ship. *Challenger* is then steady while drilling. The maps to the right indicate the routes of the Atlantic and Pacific missions.



Until recently, this natural archive, sealed under thousands of feet of water, was virtually out of reach of oceanographers tempted by its promise of a complete picture of the prehistoric past. The most refined coring apparatus in operation could only pierce the uppermost layers of

sediment to a depth of approximately 90 feet. Though the cores extracted by it contained many exciting discoveries, they enabled scientists to see through only eight million years of geologic time.

But in the last two decades, civilization's insatiable demand for

greater supplies of fuel forced the development of mobile drilling units capable of searching out the oil reserves hidden under the protective cover of the sea. And when the petroleum industry first edged offshore in 1949 to probe the continental shelves with its new machinery, marine geologists were only a few technological steps away from gaining the use of a tool that could open up the deepest layers of ocean-bottom sediment to investigation.

Now, at this very moment, a vessel that was specially designed for deep-ocean drilling is on station in the middle of the Atlantic and is boring through the sediment to retrieve samples of the sea's most distant past. Since last August, the *Glomar Challenger*, a 10,500-ton self-propelled drillship owned and operated by Global Marine Inc., Los Angeles, Calif., and manned by a team of scientists from the leading oceanographic research centers in the United States, has been sinking holes in the ocean floor down to record-breaking depths.

At the end of 18 months at sea, the vessel will have logged approximately 40,000 miles in the Gulf of Mexico and the Atlantic and Pacific Oceans on a journey after knowledge that will help date and explain the formation of the ocean basins, while also identifying the physical forces that have re-shaped them through time and are continuing to alter them today. As many as 60 cores will be taken in waters ranging from 5,000 to 20,000 feet in depth by drilling up to 2,500 feet into the ocean bottom—the record level reached by the *Glomar Challenger's* first station in the Gulf of Mexico.

This unprecedented deep-sea drill-

ing project, made possible by a \$12.6 million grant from the National Science Foundation, is being conducted under the direction of the Scripps Institution of Oceanography, a branch of the University of California. Participating in the venture with Scripps are the Lamont Geological Observatory of Columbia University, the Wood's Hole Oceanographic Institution, the University of Miami's Institute of Marine Science and the University of Washington.

Planning for the project actually began in May 1964, when the first four of these institutions established the framework for a cooperative program seeking to expand the scope of geophysical studies of the oceans through the use of drilling vessels. A year later, the JOIDES (Joint Oceanographic Institutions Deep Earth Sampling) group was given its first opportunity to take a commercial drilling vessel on a scientific mission.

But this one-month excursion was just a prelude to the present expedition—a chance to acquire valuable experience with a drillship operating in relatively shallow water. The offshore oil industry had never attempted drilling at depths much greater than the 600 feet of water found over the continental shelves, which are actually extensions of the main land masses that were submerged when the level of the sea rose after the glaciers of the last ice age melted.

A completely self-sustaining unit with evaporators for producing fresh water, the *Glomar Challenger* can store sufficient fuel and provisions to

Reprinted from Surveyor magazine, quarterly publication of the American Bureau of Shipping, © 1968.

remain at sea for a period of three months. With each of her twin screws being driven by three 750-hp electric motors, the vessel can travel at better than 12 knots.

Upon sailing from her building dock at the Orange, Texas, yard of the Livingston Shipbuilding Co., the *Glomar Challenger* went into position far out in the Gulf of Mexico. Earlier oceanographic surveys of the area selected for her second drilling site, made principally by Dr. Maurice Ewing and Dr. J. Lamar Worzel, director and associate director, respectively, of the Lamont Geological Observatory and the chief scientists in charge of this phase of the JOIDES expedition, had detected the existence of large mounds underneath the bottom sediment.

Referred to by geologists as the Sigsbee Knolls, these mounds seemed to resemble the numerous salt domes found in the shallower coastal waters of the Gulf, where rich undersea oil fields were already being tapped. With the *Glomar Challenger* in operation, hypotheses about their composition could at last be put to a test.

The drilling was carried out in nearly 12,000 feet of water halfway between the Louisiana shore and Mexico's Yucatan Peninsula. After the vessel had cut through 480 feet of sediment, a coring barrel was fixed above the bit in the drill pipe to collect a cross-section of the knoll being pierced. A preliminary analysis of the core confirmed the predictions that had been made by Ewing and Worzel 15 years ago: the Sigsbee Knolls were indeed salt domes and definitely showed signs of being adjacent to oil and gas deposits.

To remain fixed over a deep-water

drilling site, the *Glomar Challenger* depends upon her computerized dynamic positioning system. Once the vessel has found her spot, a sonar beacon is dropped to the ocean floor and four hydrophones are extended below the hull to home in on its signals. This information is then fed into a computer which automatically controls the four tunnel thrusters in the ship's hull, two of which are in the bow with the other two located aft in the centerline skeg. Each of these units is capable of generating 17,000 pounds of thrust in response to the commands of the computer and, along with the vessel's main propulsion plant, keeps her from drifting off the hole. The dynamic positioning of the vessel can also be controlled manually.

Navigating by satellite

The *Glomar Challenger* is one of the first commercial vessels to navigate with the assistance of satellites. Every two hours, the ship receives a reading of its position from an orbiting satellite. The vessel's navigational equipment also includes a digital computer for positioning accuracy.

Aboard the *Glomar Challenger*, the cores taken are cut in half lengthwise to produce two uniform samples. Then they are photographed, a description of their salient characteristics is logged and the percentage of water in the sediment is measured. A routine examination of the shells of planktonic animals imbedded in the cores is also made in order to determine the age of the strata in which they were found. These fossils are also the oceanographer's guide to the climates of the

The Glomar Challenger's discoveries will allow man to travel back 135 million years.

past. For example, the appearance of organisms belonging to a cold-water species in a sediment raised in a zone that is now too warm to support them tells a great deal about the temperature environment of the period in which they lived.

The cores do not undergo any extensive tests until they have been brought to a permanent repository on land. While aboard the *Glomar Challenger*, they are wrapped and refrigerated to prevent contamination by bacteria. Storage humidity is kept at about 90 percent so that the sediment will not dry out and contract.

Far from being a smooth, unchanging plain, the ocean basins are now recognized as areas of intense geological activity bearing every topographical feature found on land—deep canyons, giant mountains, ridges and plateaus, volcanoes and vast stretches of prairie rivaling or even surpassing their landed counterparts in height and breadth.

One of the regions of greatest interest to the JOIDES expedition is the broad crevasse that splits the crest of the Mid-Atlantic Ridge along its entire length. Scientists have speculated that the sea floor is flowing east and west away from the ridge at the rate of a few inches each year. The proponents of this theory have pointed to the extensive rift in the ridge as the site where the ocean crust is breaking apart and spreading outward and new material is welling up to replace it. The fact that earthquakes occur regularly in this region tends to uphold their hypothesis.

Another phenomenon buttressing the theory of a spreading sea floor is the existence of symmetrical magnetic anomalies on each side of the

ridge that correspond to the magnetic changes in the North and South Poles that are known to have taken place. It has been assumed that the anomalies are caused by rocks having been magnetized in opposite directions as they were formed in the rift at different time intervals and then having been carried away from the rift on both sides by the movement of the sea floor.

By drilling on a southeasterly track from New York City to the coast of Africa, the *Glomar Challenger* should be able to bring up the physical evidence that will settle the question of whether or not the sea floor actually is in motion. If the ocean bottom is moving, then the oldest sediments should be recovered closest to the continents. Also, the sediment and rock samples recovered will permit a direct comparison of the anomalies with the known record of magnetic field reversals. Measurement of the remnant magnetism in the cores will also enable scientists to fill in the chronological gaps existing in this record.

When the *Glomar Challenger* completes her voyage, oceanographers will have the material in hand to travel at least 135 million years back in time. Undoubtedly, this new-found ability to follow the patterns of geophysical evolution further along toward their point of origin will bring on a flood of new questions that future expeditions will have to answer. But the *Glomar Challenger's* discoveries will be guiding every turn in the direction of their investigations. Like her predecessor, she will have decisively marked the path toward a solution of the mysteries abiding in the sea.



by Bruce Frisch

What route and schedule
will our astronauts follow,
and how will they travel
the lunar surface . . .

Once we've reached the moon

THE UNITED STATES already has announced its intention to put a man on the lunar surface. Perhaps by mid-July; maybe even sooner.

Exciting as this thought may be, even more incredible lunar explorations are on the schedule. And they are well beyond just vague plans.

An expedition to the Marius Hills region, south of the crater Marius, has been worked out to the last detail. Route maps for the moon buggies are drawn (see page 49); the vehicles themselves have been prototyped and largely decided upon; so have little Lunar Flying Units; the logistics have been firmed up; the precise itinerary for the two astronauts who will make the explora-

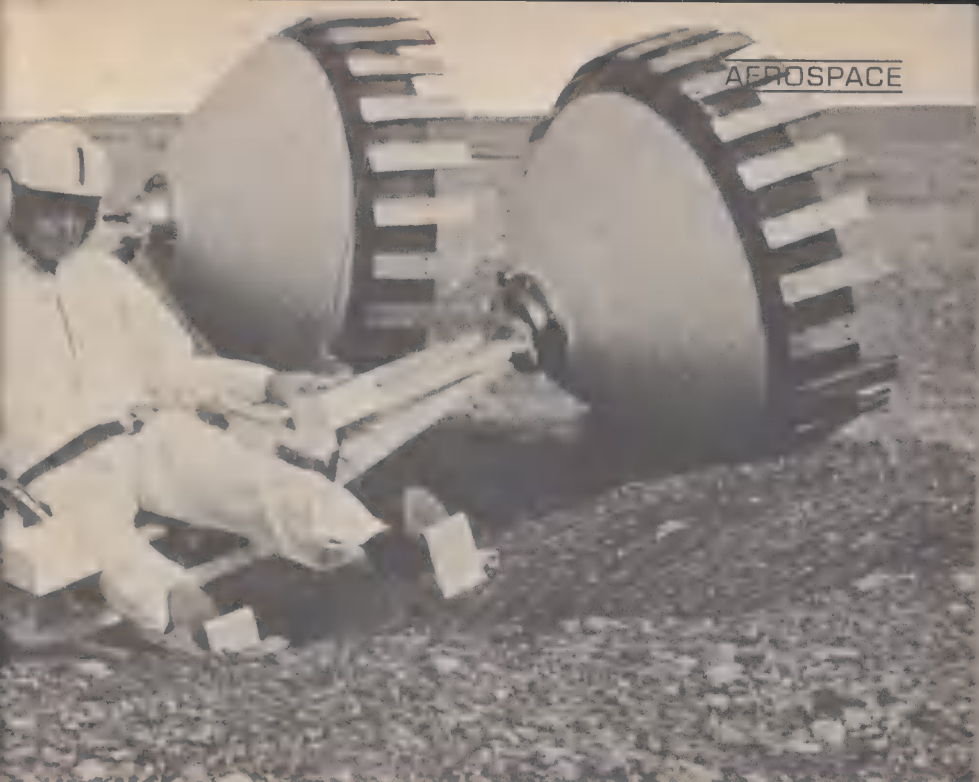


Photo by Bruce Frisch

tory trek and perform the various scientific missions is spelled out.

Target date for this major lunar jaunt? 1974 or 75.

The lunar landings scheduled for the next few years will be merely build-ups to this big one.

Any real *exploration* of the moon will not be accomplished just by one man in far-out clothes climbing from a little Lunar Excursion Module, kicking the dirt around for a minute, picking up a rock or two and climb-back aboard for ■ rendezvous and fast trip home. The real explorers of the moon's surface will have to have vehicles—both surface types and space types—to get around at all. In a clumsy space suit, an astronaut would never get more than 1,000 yards from his bug-like LEM. If

Racing across the dunes of Long Island in a moon buggy built by Grumman looks like great fun. But when this Lunar Roving Vehicle (LRV) is put to use on the moon, its driver won't travel at 20 mph or anything approximating it. His maximum speed will be only 2½ mph.

pressed, he might stagger three to four-and-half miles.

You might think that weighing only one-sixth as much as on earth would allow spacemen to move lightly across the lunar landscape. Not so. Trials in several "Peter Pan" rigs, which counterbalance five-sixths of ■ man's weight and simulate the weak lunar gravity, have shown that an astronaut will not be able to bend over without falling down or be able to kneel in his present suit.

The portable life support system

on his back will limit him to three hours outdoors at one stretch. Each man working-hour on the surface will cost \$16 million.

Obviously, this man needs wheels. NASA has known it for years and has been developing "mobility aids" with several private research corporations which have come up with numerous designs for lunar vehicles.

These vehicles are of two basic types: a moon buggy (officially a Lunar Roving Vehicle, LRV) and a one-man rocket (officially, a Lunar Flying Unit, LFU). NASA hopes to have the moon buggy ready to send to the moon in the spring of 1973. The one-man rocket—a platform-type vehicle—may require extended testing before it can be used.

Lunar Pogo by Bell Aerosystems is a version of the Lunar Flying Unit (LFU). With its two 100-pound thrust, hand-controlled engines, astronauts will make high, quick leaps during extended exploration of the lunar surface.



But the first manned lunar landing is scheduled for as early as this July—too soon for either type of vehicle to be ready. What then will these Apollo astronauts accomplish by their mission?

The principal aim in making the Apollo landings is to learn how to get there and prove we can do it. But the astronauts will also have two important scientific missions—to collect 35 to 40 pounds of lunar samples and to place scientific instruments that will radio information about the lunar surface to earth for a year. For preliminary analyses of the samples, NASA has built a whole new building in Houston, the Lunar Receiving Laboratory (*Science Digest*, October 1968).

Here, samples and astronauts will be kept pristine—free from contamination from any earth-based microorganism.

Meanwhile, experiments the astronauts set up on the moon will be transmitting back information. On each lunar landing, an astronaut will break out one Apollo Lunar Scientific Experiment Package (ALSEP), lug it off a way and spread it out. The first ALSEP will place three experiments: a seismic station, a reflector at which earth-based lasers can aim and a sheet of aluminum which will trap noble gases for determining the composition of solar wind. On the second trip to the moon, the more complex ALSEP array will be spread out.

No one can say for sure what kind of manned expeditions will follow these Apollo landings until Congress backs one scheme with dollars.

Partly as a result of recent cut-backs, NASA has not decided which of two approaches it will advocate,

Body-controlled Pogo Vehicle, another Bell Aerosystems development, is steered by body english. This simplifies the machine and is an optional method of controlling a Lunar Flying Unit instead of using hand controls.

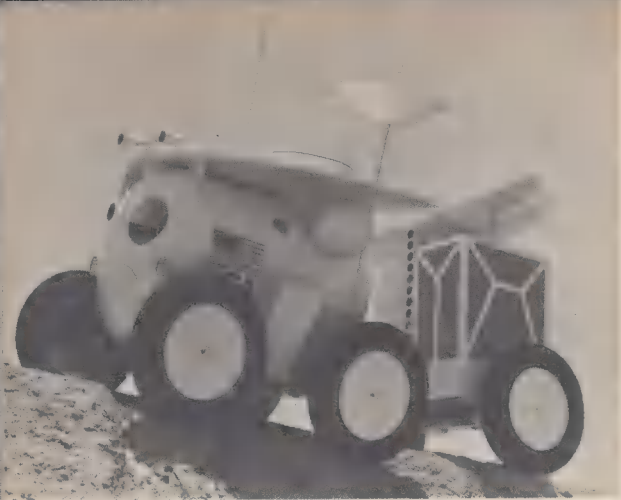
says Dr. George Mueller, associate administrator for manned space flight. Geologists, particularly Dr. Eugene Shoemaker, head of the U.S. Geological Survey, favor landing at a number of sites, he says. Others, including Dr. Mueller, want to establish permanent bases. More ambitious scientific work could be carried out there by long-staying crews who would also explore the immediate vicinity by rover.

The flyer now under study, says Dr. Mueller, is better suited for the first approach. The rover, too, is well suited, because it is able to make long trips unmanned under remote control from the earth. Past NASA plans called for keeping larger, manned rovers relatively close to home.

In the lush days of the space program, NASA figured a logical next step after Apollo would be two-launch missions. One launch would land cargo, the next, the astronauts. Planners pictured there a Mobile Lunar Laboratory (MOLAB). They would dispatch it six months ahead of the astronauts. When they landed nearby, Houston mission-controllers would steer MOLAB to them. In would climb the two astronauts for a 14-day, 240-mile jaunt, probably within a 50-mile radius.

Bendix and Boeing, with the aid of General Motors Defense Research Laboratory in Santa Barbara, Calif., received fat contracts to study MOLAB. Both came up with big land-cruisers, but Bendix had the





larger—30 feet long. Company engineers felt the 12.5-foot-long cabin would be large enough to permit carrying TV dinners for the crew instead of freeze-dried bags of food. As on all subsequent lunar rovers, every wheel of both was driven by an electric motor in the hub.

When the budget squeeze came, MOLAB was put in cold storage, but remains alive. Geologists responsible for mapping possible exploratory expeditions still take it into account and point out its value. At best though, believes Dr. Wilmot Hess, who maps scientific duties for astronauts, a long, manned traverse will not take place for at least 10 years.

As emphasis for a post-Apollo program switched to a manned earth-orbital station, the moon buggy was scaled down to the Local Scientific Survey Module (LSSM) designed by Bendix. LSSM scaled in at 1,100 pounds empty. It, also, was intended to be part of a two-launch mission. First, it and a shelter equipped for a 14-day stay would be lowered unmanned to the surface by the Apollo descent stage. (In comparison, the Apollo Lunar Module

for our first landings is designed to operate for 48 hours and allows up to 35 hours on the surface. Plans call for a one-day stop.)

The two-man crew, who would have later landed in a Lunar Module, would take out the LSSM each day for a three-to-six-hour sortie—three hours with one backpack life support unit, six when carrying a spare. After each trip, the LSSM would be plugged into the shelter electric system to charge up its batteries for another outing.

Now NASA has contracted for preliminary design studies for a further trimmed down Lunar Roving Vehicle (LRV). The light, 650-pound moon buggy would be carried with the astronauts on an *Extended Lunar Module* (ELM), basically the present LM fitted out for a three-day stay. Each day the crew would drive the "Rover" on three three-hour explorations. They might travel as much as 19 miles on each, keeping within six or so miles of the module.

Recently, Grumman Aircraft Engineering Corp., builder of the Lunar Module, has come up with an 800-pound buckboard-type buggy it has



sent charging through the craters of its simulated moonscape and bounding over sand dunes along the Long Island shore. The wheels of the vehicle are fiberglass reinforced plastic cones 40 inches in diameter and $\frac{1}{8}$ -inch thick. To drive, the operator grips a single control. He pushes forward to go ahead, pulls back to stop, presses left or right to steer and squeezes for speed. When he makes a turn, wheel speeds change and the chassis bends in the middle.

He can gun the buggy up to 20 miles per hour, but NASA is only asking for nine, tops. On the moon, he would be unlikely to do even that very often.

General Motors has found that a person's tolerance to the pitching motion usually sets the limit on speed. For their MOLAB they simulated by computer a run across the average lunar landscape seen by Ranger 7. On earth the driver could not have stood going over five miles per hour. While GM engineers do not know how he would react to the moon's one-sixth G, chances are he would slow down more, because the wheels would leave the ground more.

Four-ton MOLAB (left) would have carried two astronauts on a 14-day, 240-mile trek on moon. Plate on top is meteor shield. GM chassis (center) for Boeing MOLAB climbs easily over a pile of dirt. Like MOLAB, this GM Mobile Geological Lab (right) could house two men for up to two weeks. Air conditioned, it could hit 25 miles an hour on surfaced roads and climb 45 percent grades.

While NASA has instructed the moon buggy's designers to give the economy mission with the light LRV the most study, they have left open more ambitious alternatives. Secondary considerations will be given to a similar rover weighing 1,000 pounds and to stays lasting up to 14 days.

After the astronauts leave the moon on any of the missions, Houston controllers will steer the Rover by remote control as far as 620 miles over the following six months to rendezvous with a second manned landing. This stage of exploration is expected to begin after 1975. Imagine taking a stereoscopic-TV tour of craters and rilles and volcanic domes as a controller. It could be a nerve-racking job. Because of the distance between the moon and earth, the picture you received would have

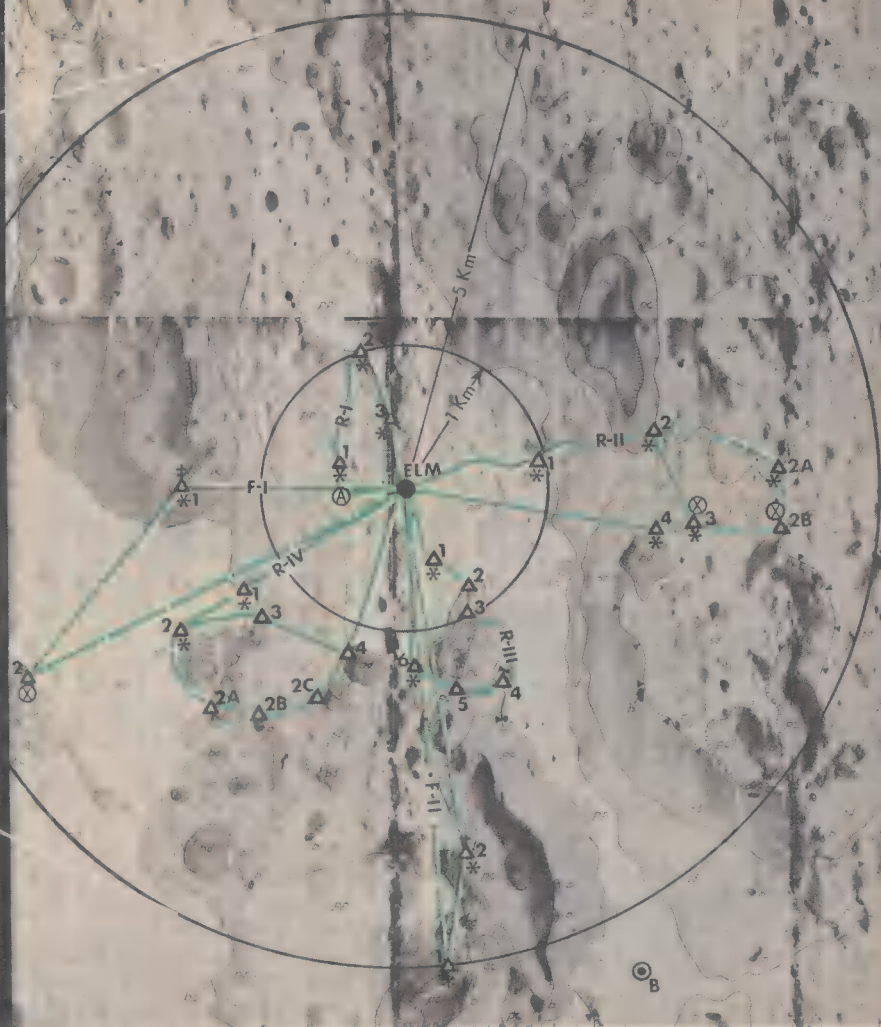


In the three-day Marius Hills mission, astronauts would drive and fly in the area of the ridge system that runs down the middle of the Oceanus Procellarum, the largest mare on moon.

been taken $1\frac{1}{4}$ seconds ago. And it would take another $1\frac{1}{4}$ seconds for your steering or braking commands to go beaming back to the LRV.

Grumman has run tests in which operators guided a Jeep or a MOL-

AB-type vehicle by remote control with all commands delayed $2\frac{1}{2}$ seconds. In some cases the operator was at one end of Long Island and the vehicle was at the other end at the company's simulated moonscape.



Mission Planning Explanation



Landing site of Extended Lunar Module



Lunar Rover Vehicle (LRV) Traverses



Extended Lunar Rover Traverses



Alternate landing area



Deploy explosive charges for Active Seismic Experiment



Deploy Alsep



Deploy 1-geophone array for Active Seismic Experiment



Deploy 3-geophone array for Active Seismic Experiment



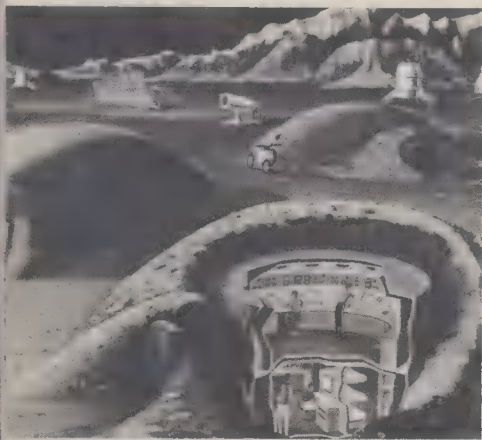
Lunar Flying Unit (LFU) Traverses



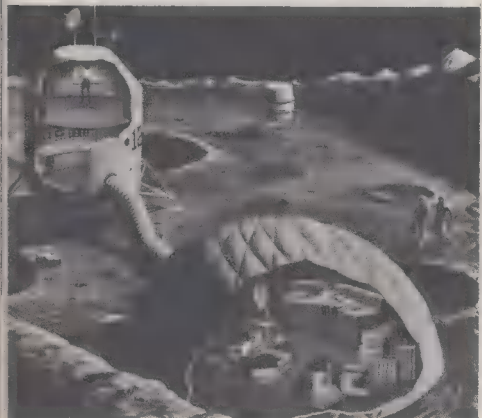
Deploy communicator repeater



Traverse stations



Advanced lunar base (top) could be double-walled cylindrical structures sunk in ground and heaped over with loose material for protection. First stage of lunar base (bottom) might be a large landing vehicle with foldable dome to be inflated later for additional space.



Surprisingly, the driver could not steer confidently at any speed over $2\frac{1}{2}$ miles per hour.

Considering all the difficulties, GM engineers have assumed the vehicle will be driven stepwise. It would be commanded forward ■ short distance, and stopped while the operator back on earth looked

around and set ■ new course.

Members of the U.S. Geological Survey's Astrogeology Branch in Flagstaff, Ariz., have studied possible voyages of exploration. To help them develop instruments and techniques astronauts might use on the go across the moon, GM built an eight-ton Mobile Geological Laboratory. The ten-foot-high, 16-foot-long, rubber-tired gargantua can house two men in air-conditioned comfort for up to 14 days without their going out. In addition, the astrogeologists use ■ more rover-size, stripped down Jeep around their simulated moon-scape.

They have written two itineraries. The first, to the Marius Hills, one can imagine taking place in the mid-70s. The Marius Hills lie across a ridge system that runs down the middle of Oceanus Procellarum, the largest mare on the moon. They are the most concentrated and varied array of probable volcanic features on the lunar surface. As such, they lend further suspicion that the ridge is similar to the earth's mid-ocean ridge.

This hypothetical expedition would be landed in an ELM carrying two men, and two flying units. A separate, smaller package made up of the rover and most of the scientific equipment would have been dispatched by Titan IIIC. During their three-day stay, the astronauts would take one two-hour and three three-hour drives in the rover and make two flights with two stops each in one of the flying units. One flying unit would be reserved for rescue. As assigned to North American Rockwell and Bell Aero-systems for preliminary design analysis, the Lunar Flying Unit would weigh 180 pounds

dry. On 300 pounds of leftover descent stage fuel it would take one man 10 to 15 miles. The LFU will be able to last through at least 30 sorties in several weeks.

On this particular landing, the astronauts would cover about 12 miles in the flier, almost 14 miles in the rover, tote back about 880 pounds of samples and perform other scientific chores.

Enough payload on the Titan IIIC lander would remain unused, NASA believes, to pack materials to extend the stay by two days and fuel three more flights, so they are working up a five-day plan for the same area.

Flagstaff's second expedition looks toward the far future. The site, Mare Orientale, lies at the western limb. To communicate reliably with the wanderers we would need to relay messages through a lunar communications satellite. Furthermore, the resources of the expedition would have to match the scale of Orientale. Six hundred miles across, the mare evidences the most recent large meteor impact. The Cordillera, outermost of the two mountain ranges ringing the area, rises 20,000 feet, with sharp drops of over 9,000 feet. Traveling within the mare, a vehicle would roll over a smooth surface as little as three percent of the way.

By the time such a trek takes place, we may have bases on the moon. For what it's worth at this uncertain time, NASA planning seems to lean toward establishing a settlement of 12 to 18 men after a post-Apollo period of vehicular explorations lasting up to two weeks. Werner Von Braun, who bossed the building of the Saturn V rocket, says with reasonable uprating it could handle a 12-man base. Two launches

a year would deliver supplies; eight would rotate crew, which would mean eight returns also. The way things stand now, however, the last Saturn V will be finished in the summer of 1971. But a scheme for a reusable launch rocket is in the wind.

Most studied, says Philip Culbertson from NASA headquarters, has been a base for 12 to 15 men. In one sequence considered, the manpower for the base would gradually amount to as many as a dozen men. Fourteen launches over 43 months would deposit men and supplies.

Further populating the moon may depend on locating water. "Should water be found in relatively easily developed deposits, motivation for more rapid buildup to large bases would be inevitable," estimates Dr. Rodney Johnson, also from NASA headquarters. The water would be split into hydrogen and oxygen to fuel homeward-bound launches and vehicles that may include rovers, construction equipment, mining machines and a fixed transportation network. Hydrogen by itself makes the best nuclear reactor working fluid.

Some scientists believe we will find a lot of water on the moon. Richard E. Lingenfelter of the UCLA Institute of Geophysics thinks permafrost lies about 325 feet below the surface. As uncovering it relieves the pressure, Lingenfelter theorizes, it will turn to liquid and squirt out of the ground with enough force to gush 3,000 feet into the sky.

But putting first things first, just getting to the moon is our immediate concern. With luck, that part of the schedule may be accomplished in a very few months. At this point no one is certain which plan will be followed once we've reached the moon.

Big smoke, *little babies*

by Arthur J. Snider

A PREGNANT WOMAN who smokes is likely to have a smaller baby than a non-smoker, according to Dr. Harry Medovy of the Children's Hospital, Winnipeg, Canada, who says such infants will weigh an average of eight ounces less at full term.

Nevertheless, they have a good chance of survival; perhaps even better than those born to non-smoking mothers because of their smaller size in passing through the birth canal.

"However, the advantage disappears when the total reproductive picture is taken into account," Dr. Medovy said in a report to the American Academy of Pediatrics. "The number of abortions, miscarriages and reduced fertility is probably much greater in women who smoke."

The pediatrician says it is not known why smoking mothers have smaller babies, but suggested that some constituents of the absorbed smoke, such as nicotine or carbon monoxide, might affect the fetus. Animal experiments have shown this.

A chest physician says there is a physiological basis for claims by some smokers that cigarettes calm them and by others, that cigarettes stimulate them.

Dr. Andrew L. Banyai says carbon monoxide, a poisonous gas formed as one of the incomplete combustion products of tobacco, has an affinity for hemoglobin, the oxygen-carrying pigment of red blood cells. Carbon

monoxide thus reduces the oxygen-carrying capacity of blood going to the brain. The result is a slight drowsiness and a pleasurable, languid sensation.

Cigarettes also depress skin temperature in the fingers and toes by constricting the tiny blood vessels. This cooling of the skin may register as a calming sensation in persons hard-pressed by strain, anxiety or undue excitement.

Those who find cigarettes a pick-me-up are probably responding to the stimulating substance, norepi-



nephine, which is liberated in the body by nicotine, Dr. Banyai explains. This may be the reason many people have a desire to smoke on rising in the morning.

Cigarettes also make people feel better by increasing the heart rate 15 or 20 beats a minute, causing a greater heart output and blood flow through the body.

Cigarettes can give a desired calming or stimulating effect, but is it worth the price? Not in Dr. Banyai's opinion. He says:

"Because of its possible grave pathologic consequences, cigarette smoking must be considered an undesirable, hazardous euphoriant."

Non-bibulous baggy eyes

The baggy-eyed fellow trooping into the office amid the knowing smiles of his colleagues has a medical excuse for his seeming hung-over appearance.

He was born that way.

"While most people regard the puffy eye as a sign of dissipation, the problem arises in many cases as a result of a congenital condition," explains Dr. McCarthy DeMere, a Memphis plastic surgeon.

Some people are born with a weak membrane lining the bony socket of the eye. This permits the liquid fat around the eye to push outward, forming a hernial sac in the lower eyelids. The hernia causes symptoms just like a hernia elsewhere in the body.

The late comedian, Fred Allen, Senator Everett Dirksen and the late Alfred P. Sloane are typical of the congenital type, he points out, adding: "The true orbital herniation patient has been unfairly maligned ever since the early Greeks wrote, 'As in the eyes, when the lower lids are pendulous, you may know a bibulous fellow'."

The surgeon is particularly solicitous of young people for whom the baggy eyes constitute a cosmetic defect. "We recently had a young lady in her 20s who works in a beauty parlor," he said. "And every day somebody would make some kind of a remark to her, like 'Boy, you must have had some party last night'. This

girl doesn't drink or party. She just had to take it."

Surgery is able to correct the condition by attaching the weak membrane to stronger connective tissue overlying the orbital rim. The two-hour operation also can be performed on older persons for whom baggy eyelids are part of the aging process.

New sight with sound

Ultrasound, high frequency vibrations beyond the hearing capability of the human ear, have been used in the past for cleaning machined parts, testing industrial processes, stimulating circulation and cleaning kitchen pots and pans.

Now it has been called upon for a new assignment. A New York eye surgeon uses ultrasonics to remove cataracts—eye lenses which have become opaque to light.

Dr. Charles K. Kelman of Manhattan Eye, Ear and Throat Hospital, New York, causes an ultrasonic needle probe to vibrate at 40,000 cycles a second, which imparts enough energy to the lens to liquify it. The fragments of lens are sucked out through the hollow needle.

Dr. Kelman says the technique is much faster and less traumatic than conventional surgery. Instead of a week in a hospital bed, and more days recuperating, the patient can return to work in a few days. The conventional incision requires six to eight stitches to close. For ultrason-

ics removal, a tiny incision only large enough to insert a needle probe is required. A single suture can close it.

The technique is still under development and not widely used but Dr Kelman believes that one day it will make cataract removal relatively minor surgery.

Resodding the scalp

"Thick hair, thick head."

"What He hath scanted man in hair, He hath given him in wit."

"Grass will not grow on busy streets."

These and many other witticisms have been penned to console the bald, yet through the ages there continues an unrelenting search for remedies.

In recent years, plastic surgery—the art of resodding the scalp by



transferring hair from fruitful areas to barren spots—has drawn the most attention. Dr. Norman Orentreich of New York City developed a punch technique that replants tiny plugs of hair from the back and side of the scalp to the top.

Another new operation has just been reported in the "Journal of the International College of Surgeons" by Dr. Louis J. Feit, director of plastic surgery, New York Polyclinic Medical School and Hospital. Designed chiefly to restore the frontal hairline, it is called the bilobe flap.

"Once the patient has the natural looking front, he doesn't worry about the back," Dr. Feit explains. "He can, if he chooses, wear a hairpiece."

Dr. Feit takes a flap of hair from each side of the head, rotates and pulls them toward the brow. To replace the denuded portion of the head, the skin is pushed forward from the neck, where it is very mobile. No replacement graft is necessary.

The flaps contain 100 to 500 hairs as compared with only five to ten hairs in the punch grafts, the surgeon explained. In addition, the graft includes the epidermis, dermis and underlying tissue of fat glands, sweat glands and supportive circulation. The donor site is healthy since the hair there is fed with the large temporal blood vessel.

The newly-transplanted hairs are permanent and grow rapidly.

Lead in the head

By whirling a patient in a centrifuge normally used in space research, a bullet in the brain of a 63-year-old cook has been repositioned to a safer spot in his head.

The man had been shot twice during a restaurant robbery. Bone and bullet fragments were removed by Dr. James W. Markham of O'Connor Hospital, San Jose, Calif., but the main part of the .22 caliber

bullet remained. It then shifted into the third ventricle, a cavity in the center of the brain through which all brain fluids drain. If the bullet moved only a few millimeters, it would block the opening of the drain, resulting in a death because of the buildup of fluid pressure on the brain.

An operation to remove the bullet was considered too dangerous. Dr. Markham conceived of the idea of subjecting the patient to the whirling motion of the centrifuge at a speed that would subject the lead bullet to six times the force of gravity—enough to move it through soft brain tissue. The man was placed in the machine at the Ames laboratory of the National Aeronautics and Space Administration. The spinning motion moved the bullet out of the third ventricle into the lateral ventricle, a site where it could do no harm.

Diabetes may be dad's

Physicians in training at the Indiana University Medical Center are being taught to ask their patients about the quirks and miseries of their ancestors.

The reason lies in a growing body of evidence that patients can inherit a genetic factor which may be important to their health. Some of these factors work directly to produce more than 2,000 inherited diseases so far known, such as diabetes. Others work more subtly. They are the inherited factors which increase the risk of high blood pressure, for example. Still other patients may have inherited a chemistry which reacts violently to specific drugs. Diseases which are easily treated in some peo-

ple may actually be fatal to others.

A patient may not know that an ancestor had diabetes. But he may have noticed that he seems to have Uncle Fred's unquenchable thirst,



which could be a symptom of diabetes.

The importance of detecting inherited disease early lies in the capability of limiting its effect, explains Dr. A. Donald Merritt, chairman of the department of medical genetics at Indiana University.

Football exercise foibles

Exercises performed by football teams before games are usually more "show" than useful, says Dr. Richard H. Pohndorf of the University of Illinois physical education department.

They may even be harmful. Deep, forceful knee bends, duck waddles and other maneuvers which cause forceful bending may actually be harmful by increasing susceptibility to knee injuries, he says.

"Side straddle hops (jumping jacks) are almost worthless," he contends. "The 'rocker' exercise (lying

on the front and rocking back and forth) does nothing but possibly bruise the breast bone. Crossing the legs in a standing position and touching toes may injure the groin or hamstring muscles or strain the lower back."

Pohndorf says the pre-game exercises are usually part of the "mystical or pagan" rites to help set the stage for the game.

In another area of football conditioning, Dr. Pohndorf says the idea of giving players honey just before a game to raise their energy levels is "a foolish fad."

"Honey elevates the blood sugar and this tends to make the player more lethargic," he points out.

The tendency to feed players steaks is also wasteful and a costly diet fad. Other less expensive protein foods are just as nutritious.

Even though it is known that minimum weight makes a player faster and more agile, many coaches and players believe that loss of weight is also a loss of strength. They believe mistakenly that one converts fat into muscle through hard exercise.

"There are still many training tables that pay little attention to dietary planning other than volume," says Pohndorf. They provide a feeding station and let the players go at it in a wanton manner. The fat and protein eaten before a game provides a gastric problem. Because of slow peristalsis (stomach churning in digestion), the food acts like a swallowed shot-put, lodged in the 32-foot alimentary canal to be carried around during the game."

Compared to such sports as rugby, football is not a fitness demanding game, the scientist said. The sum of times the ball is put into play until

the whistle blows to end play is about 12 minutes. Since most players are specialists on offense or defense, they are under actual game conditions for about six minutes in all.

"Each player travels about a mile during the afternoon and much of this comes from running onto the field and returning to the bench," says Dr. Pohndorf.

Cancer cream shows promise

A cream containing the cancer-fighting drug, 5-fluorouracil, or 5FU, is being applied to the skin for treatment of skin cancer at the Tulane University medical school. Dr. Martin S. Litwin, assistant professor of surgery, says no recurrences of cancer have been seen following treatment of 146 cancerous skins areas in 61 patients. Some have been followed up for as much as two years.

Patients apply the cream once a day for six to 12 weeks. Many had undergone surgery for previous skin cancers and "were running out of skin."

The victims included many farmers who were sensitive to the ultra-violet rays of the sun. Their cancers were especially prevalent under the eyes, on the back of the hands and on the bridge of the nose.

The ointment works rapidly, Dr. Litwin explains. During the 10th to 14th day of treatment, the cancer becomes inflamed. In two or three weeks, a scab appears and eventually drops off after healing has started.

"The surface of the cancer seems to be 'melted' by the 5 FU and the whole body seems to reject the malignant cells," says Dr. Litwin. "Normal cells are not affected."



2,000-year-old seal

THIS SPRING, *Northwestern University* investigators will study the body of a Weddell seal that died approximately 2,000 years ago but is still in remarkably good shape as can be seen in the photograph above.

The animal has been preserved in the frigid atmosphere of Antarctica's dry valleys, where about 90 ancient specimens have been discovered by a National Science Foundation team. The Northwestern researchers will compare the tissues of the preserved seal with those of a modern Weddell seal to see what genetic and cellular changes have occurred.

In particular, they'll be studying:

the content of deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) in the tissues; the glycolytic enzymes in the muscle tissue which might still be functional; the structure and function of cells; enzymic activity within cells; structure of whole organs; intestinal bacteria.

The McMurdo seals are by no means the oldest preserved specimens of animals known. The Siberian mammoths have been carbon dated at up to 30,000 years old, but treatment with chemical preservatives and storage in heated museums has made them unsuitable for detailed biochemical studies.

Earth is slowing down

Two paleontologists from *Yale University* say the earth is slowing down. Counting living mollusks'

growth increments—one thickness of shell material in a given amount of time—as a basic time unit, Giorgio Pannella and Copeland MacClinton measure the fossilized shells of



Freeze-dried mouse is held by research assistant at North Texas State University zoology museum, Denton, Texas. Water is extracted from animal's body in frozen vacuum state, so it is preserved without decay. Result is life-like light specimen good for museums.

ancient mollusks. They calculate that in the Cambrian Period, some 500 million years ago, the lunar month was about 31.56 days long. Now it is only about 29.17 days. The slowdown rate was apparently higher around 280 million years ago and then again from about 75 million years ago to the present.

Chemical transfer of fear

Proponents of a chemical transfer of learning got a big helping hand from Dr. Georges Ungar of *Baylor University College of Medicine* recently. He claims to have transferred an extract from the brains of rats, made fearful of a dark box, into mice who had not been trained. The mice became more fearful of the

box. Four laboratories other than Dr. Ungar's have had similar results; two report negative results. Dr. Ungar thinks the transfer factor is a specific agent concerned solely with dark avoidance. Extracts from donor animals trained in another avoidance reaction did not affect dark avoidance in the recipients, and vice versa.

Itsy bitsy Icarus?

Icarus, the asteroid that came within 3.05 million miles of earth last summer (*Science Digest*, June 1968) is smaller than astronomers had believed. The Jet Propulsion Laboratory at *California Institute of Technology* tracked the asteroid with radar during its closest approach and reports it is about a half-mile in diameter.

Before the radar estimates were made, Icarus was thought to be about a mile in diameter. The revised estimate makes Icarus small enough to be lost in Grand Canyon, as Dr. Richard M. Goldstein of JPL's Radar Astronomy Section pointed out.

"We found indications, too, that Icarus is rough, even jagged, and perhaps shaped like a peach stone," said Dr. Goldstein. "However, the radar reflections are unable to indicate whether the surface might be stoney or metallic."

Caltech made seven probes of Icarus over a three-day period at JPL's Goldstone Tracking Station in the Mojave Desert.

Sneeze in the sun

So you think you'd like to move to a warmer climate to avoid colds? Ac-

cording to a *University of Wisconsin-University of the Philippines* study, you may sniffle more than ever in the tropics. The incidence of respiratory infections and their relative importance were greater in Philippine students than in Wisconsin students, averaging 64.2 percent of total admissions at the Philippines infirmary and only 30 percent of total admissions at Wisconsin. The estimated rate for respiratory admissions of 49.4 per 1,000 students in the Philippines was more than double that of the University of Wisconsin's 24.3.

Persistent Pueblo culture

The endurance of the ancient Pueblo Indian culture in the American Southwest is "the most remarkable example of ethnic tenacity in the New World," according to an anthropologist who is himself a Pueblo. Dr. Edward P. Dozier of the *University of Arizona* reports that Pueblo beliefs, religious rites and communal way of life persist along the Rio Grande River in northern New Mexico and northeast Arizona.

Few Christian beliefs and rituals have become part of the Pueblo culture after hundreds of years of forced indoctrination, first under the Spanish and later, towards the end of the 19th century, by the U.S. At one time, Indian children were forcefully recruited under U.S. laws and sent to boarding schools where the Indian language and customs were prohibited.

Instead of eliminating the Pueblo culture, the restrictive measures drove it underground. In the 1930s, U.S. policy underwent a shift; now

the trend is to protect Indian culture and customs. Indians are given considerable autonomy over internal affairs and any changes take place at the pace they set themselves. Under the new regime, the Pueblos have gradually shifted from dependence on subsistence farming and an economy based on corn, beans and squash, to a cash system.

The Pueblo culture had its "Golden Age" in the 14th century, when it covered vast portions of the southwestern United States. The Indians built two-, three- and even four-story apartment-like dwellings and used ditches, dikes and canals in the larger towns. Towards the end of the 1300s, however, the Pueblos abandoned many flourishing towns and retreated to isolated villages in other sites. The reasons for the retrenchment remain a puzzle to anthropologists.

We're more like pigs

"Man is more nearly a pig than a dog," says Dr. Alfred Edward of the *University of California at Davis*, who is raising miniature pigs for medical research. Pigs get arteriosclerosis and ulcers, Dr. Edward points out. Their heart is in the same location as man's and has the same structure. Miniature pigs are even closer to man than normal sized swine. An adult miniature weighs from 140 to 160 pounds, more nearly the average weight of adult man compared to two or three times as much for a standard pig. The small swine at Davis are a cross between the North Carolina guinea hog, the Louisiana Piney Woods pig and a wild Mexican hog.

A black and white photograph showing a person's hands working on a piece of fabric, possibly a garment, with a sewing machine visible in the background. The person is wearing a light-colored long-sleeved shirt. The fabric has a dark, possibly floral or geometric pattern. The sewing machine is a vintage-style machine with a wooden cabinet. The overall scene suggests a domestic or workshop setting.



Industrial cutting and welding may be more cheaply done thanks to an electron gun (above) developed at Harwell, England's Atomic Energy Research Establishment. Device is useful in cutting and profiling silica and aluminum and other metals. Gun can be made at exceedingly low cost according to report.

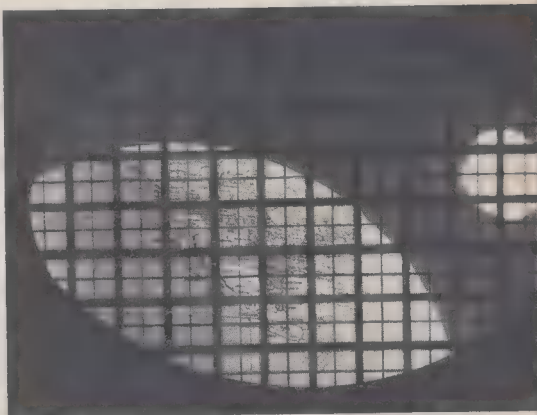


"Airbrasive" (left), an industrial tool originally intended for cutting fragile or brittle materials with a thin stream of compressed air, is being used to clean ancient artifacts at the Smithsonian Institution in Washington, D.C. Developed at the Pennsalt Chemicals Corp., New York, N.Y., the air gun is being used to clean this ancient American Indian leather cape.

Fire extinguisher for outer space (right) has been developed by Southwest Research Institute, San Antonio, Tex. Extinguisher consists of a pressure vessel containing a specially designed bellows. Layer of freon gas lies between vessel and bellows. The gas forces the bellows to contract and expel the extinguishant even in a weightless state. It weighs less than eight lbs., and was aboard Apollo 9.



A computer-controlled optical system may bring dead oil fields back to life by analyzing old well "logs"—wavy lines on rolls of paper which indicate subsurface geological conditions. Mobil Oil Geophysical Services.



Space window (above) for inflatable structures that may house space explorers is made of silicone polymer. When collapsed or folded, very little room is taken in the spacecraft. By UniRoyal, Inc., New York, N.Y.





Photographs: Three Lions

Flying at supersonic speeds at great height creates problems of air pressure, weightlessness and many others for SST passengers. Oxygen masks like the one above will be available aboard France's SST, Concorde 001.

Can passengers take the punishment of Supersonic flight?

MOST of the aviation skeptics stopped shouting, "Man wasn't meant to fly!" decades ago, but a whole new generation of doubters has been spawned by the SST. "Man wasn't meant to fly at supersonic speeds!" is their new cry—and the way things have been going, they may be right.

Even if you completely disregard the fact that the SST was designed primarily to carry large numbers of *people* and look at it purely as an engineering venture, an experiment in flight, the skeptics' case gets all the stronger. The plane has been plagued by one engineering blunder after another. (Read "Engineering Shambles: the SST," *Science Digest*, January, 1969.)

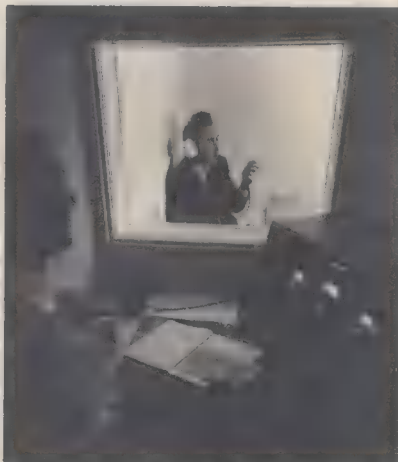
First flight dates on the Concorde, the joint British-French SST project, are already a year late. The American SST by Boeing is still stuck on the ground and has gone through one major design change after another. The only SST to have made it into preliminary sub-sonic flight is the Soviet Union's TU-144 which first flew in January.

But the problems of making the airplane *fly* are by no means the major ones—there's a whole snake's nest of problems that can't be totally solved until *after* the plane is in the air. The problems involve people.

SST designers expect to cram as many as 250 passengers, their luggage and additional cargo (totaling 56,000 pounds) into a practically windowless, city block-long machine and fly them all a Mach 2.7 (1,800 mph) 15 miles high in the sky.

All four countries involved in SST programs have been experimenting for years with the human factors of supersonic flight. Can passengers really stand up under the physical stresses of flying so fast and so high? Sud Aviation, the French company which has built and will soon test fly the Concorde 001, has a team of physicians, designers and technicians working together to make sure that they don't wind up with an SST-full of injured or dead passengers whose blood has boiled at 82,000 feet or have been quick-frozen at 15 miles high in the stratosphere. These two physical dangers are the most extreme and the most unlikely, but there are numerous physical dangers and discomforts that must be eliminated before any SST can begin flying passengers anywhere. Obviously flying at 1,500-plus is going to present some difficulties. The temperature of the aircraft's outer skin reaches almost 200°F. at Mach 2.2 and can soar as high as 450° to 500°F.—far beyond what man or machine can tolerate. In order to lower these

Volunteer enters heat caisson (below) to test pressure suit which simulates sea level even though caisson pressure is like that at 82,000 feet. Imperfection in suit could mean death. To test effects of high altitudes on hearing (right) volunteers enter pressure units and then have hearing tested with sounds ranging from monotonous to shrill screams. Body functions under various atmospheric pressures are tested by Concorde team (below). They're measuring characteristics of pulmonary ventilation. Electroencephalogram (opposite) measures brain waves of volunteer who is reacting to visual phenomena such as the intensity of light and colors.



temperatures, the Concorde has refrigeration tubes which wind through the walls of the aircraft.

The greatness of the intended cruising altitude is another complication. The Concorde team is doing intensive research with pressurized cabins and high-altitude garments and masks. Volunteers enter heat caissons or pressurized units that can simulate the pressure of any altitude from sea level to 15 miles high.

The volunteer wears a special suit and mask that can maintain an optimum pressure and temperature—even when the pressure in the heat caisson corresponds to that of altitudes approximating spacial vacuum.

The cabin of the Concorde 001 will be pressurized, and passengers will travel in an environment as pleasant as at sea level. But Concorde is studying the pressure suits all the same as an emergency precaution.

Fifteen miles above the earth the brightness of the sky is about one-third of that on the ground at noon. The blue dwindles in color, and is replaced by a tremendous glare that could permanently damage the eyes. All windows on the Concorde (tiny though they are) will be tinted to protect the passengers. Pilots will wear special protective goggles.

Since most SST flights will not last more than a couple of hours, no one



is likely to suffer any eye damage from the glare.

Just getting up there to that great height is a potential discomfort for the SST passenger. If you are impressed by the rate at which ordinary jet airliners climb, you will be shocked by the acceleration rate of the SST. When it comes time for the pilot to level off after a steep climb to his cruising altitude, the passengers may go through a period of weightlessness. Books, magazines and drinks may suddenly attach themselves to the ceiling because of the abrupt change in direction.

The Concorde team is also working on a filter system that will provide fresh air for passengers. This is a must because when the plane is above 65,000 feet (12 miles), a region is entered that is dense with ozone. If too much of this ozone, a toxic form of oxygen, enters the cabin, the possibility of the passengers' hemorrhaging becomes almost certain. Even if small amounts of this gas creep into the cabin there could be irritation to the respiratory system. And since the stratospheric air outside must be utilized and mixed with oxygen, something has to be done about the ozone. The filter apparatus on the Concorde will decrease the density of ozone to .1 in a million parts—well below the margin of safety.

Even though the Concorde team is certain that passengers are in no immediate danger, they are not so sure about the SST crew's safety as far as protection from cosmic rays is concerned. Above 69,000 feet cosmic rays become quite intense—three times as strong as at sea level. The rays are not dangerous if a person is exposed for only a few hours,

which is the length of a normal SST flight; but pilot and crew would be making numerous flights and could be in serious danger. To avoid such dangers, crews will not fly more than 50 hours per month at the high altitudes.

One of the most difficult physiological effects of flying at supersonic speeds is the shift in "circadian rhythm." The natural biological



clock that is within all of us gets thrown out of whack when we cross oceans or continents. The French are studying circadian rhythms by sending volunteers down into caves for periods up to six months long. There they live completely alone without any concept of time. (Read "Six cave explorers who lived outside of time," page 8, this issue.) Physiologists have no cure for "jet

exhaustion" caused by the upset of biological clocks at this time.

The list of physiological complications during supersonic flight goes on and on. Many of them have been solved—at least on paper or in the laboratory. But no one can be certain what will happen when SSTs start flying on a regular basis. Earliest estimates indicate service by 1976.



The metabolism of a pilot is checked (opposite) during his stay in a pressure unit which is simulating a very high altitude. He is asked to do certain exercises while wearing a pressure suit. The facial covering is an oxygen mask. Pilots go through tests in a centrifuge (left) which is duplicating the gravitational pull exerted on an airplane at very high acceleration. The pilot is rotated rapidly in the centrifuge and the effects are monitored by physiologists. Russia's SST, the TU-144 (below) was the first of the supersonic planes to fly. Even though it flew only at subsonic speeds, it is well ahead of the SST programs of France, England and the United States. It is shown here with a Soviet fighter plane escort.

Pictorial Parade





Who says that a Garden of Eden has to exist in the wilderness? St. Louis has come up with an indoor Eden that is sheltered by a strange-looking flying saucer-shaped structure. This geodesic dome harbors plants from all over the world with wide-ranging climate demands—all of which are being satisfied by a unique climate control system—a Climatron.

EDEN
under
a
geodesic
dome



Sitting in the traditional surroundings of the Missouri Botanical Garden, the Climatron approach offers an intriguing view to the visitor who can't help but be curious to discover what lies beneath that geodesic dome. Once inside (above), the visitor experiences the sensation of traveling from a dry, hot climate to the humidity of a real tropical rain forest.

by Barbara O'Connell

THE ATMOSPHERE is definitely tropical: lush green foliage, some of it 70 feet high; a balmy breeze, a splashing, 12-foot waterfall. And isn't that a banana tree, complete with a ripening bunch of fruit? Arching high above, however, is a domed roof. The tropical scene is part of St. Louis' Climatron, a greenhouse as different from the traditional rectangular structure as a car is from a buggy.

In the first place, the Climatron looks different. Opened in 1960, it's

a geodesic dome, the structure invented by architect Buckminster Fuller, who served as a consultant when the St. Louis dome was erected. The roof and walls consist of two layers of lightweight aluminum tubing arranged in hexagonal patterns, the inner layer lined with plexiglas and suspended from the outer. Seventy feet high and 175 feet across, it shelters more than half an acre of growing space.

Perched in the traditional surroundings of the Missouri Botanical Garden, the Climatron looks like a flying saucer about to take off, an ef-

fect that's heightened at night when its blister-shaped skin is illuminated. The unusual appearance of the Climatron is actually a by-product of its function; Dr. Frits W. Went, the Garden's director, wanted a greenhouse that could grow tropical plants well. In the Climatron, he has it.

"There are no dark corners, no internal supports in here," pointed out Dr. Derek Burch, chief horticulturist at the Missouri Botanical Garden, as we walked through the dense foliage.

The Climatron, he told me, has over 1,000 varieties of plants, all of them tropical but hailing from various parts of the world: Hawaii, the West Indies, Africa, Indonesia, etc. How can one big room keep all these

plants happy? The secret is in the building's unique climate-control system. The "nerve center," a 15- by 20-foot panel just inside the door, controls a system of fans, vents and spray nozzles that can automatically give a tropical plant just the climate it wants: a breezy Hawaiian climate in one area; a dry, hot climate in one; a humid rain forest in another.

"No other greenhouse has such a range of tropical climates under one roof," remarked Dr. Burch.

The system, he explained, works like this: Warm air from the Garden's main boiler house comes in through a tunnel and is released at one side of the Climatron through unobtrusive vents. This area is hot



"Nerve center" of Climatron (top) is 15- by 20-foot panel just inside door that controls fans, vents, spray nozzles. Lights around perimeter (below) light Climatron at night, and metal sensors keep tabs on temperatures in greenhouse. Banana trees, water fall (right) add touch of tropical forest lushness.



and dry. As the air crosses the Climatron, aided by giant fans, it picks up water from the foliage and carefully-arranged ponds, arriving at the center as hot, moist air—a typical rain forest climate. Then the air drifts down to the “Little Hawaii” area, and it’s cooled by mist nozzles.

An in-between area, cooler and dryer than the rain forest but hotter than Hawaii, provides a “high tropics” atmosphere.

Outside climate plays an important role in the way the equipment operates. In winter, the Climatron is usually heated only; in St. Louis’ hot summers, on the other hand, it’s cooled. During the mild fall and spring weather, both heating and cooling systems may be at work.

A dozen sensors keep tabs on the temperatures at various points in the Climatron. Most of the sensors are now hidden by foliage, but one in the high tropics is still visible—a tall metal tube topped by a metal box. It looks like a peculiar flower. Inside the box is a thermometer. The sensors are connected to the nerve center panel by cables, their readings appearing automatically on a graph.

“All we have to do is take a look at the graph and we can see what the temperature is anywhere in the Climatron,” noted Dr. Burch.

What if something goes wrong—a power shortage, for example? “That happened once a year or two ago during the summer,” he said. “But we have an auxiliary generator now so we used that until we got power again.” A system of “overrides” makes it possible to change the temperatures manually if the outside weather changes drastically or for, say, an evening social event when higher day temperatures are desira-

ble instead of evening temperatures.

Tropical plants flourish under these carefully-controlled conditions. At the end of the Climatron’s second year, most of the vegetation already looked just as it does in the tropics—possibly even a little better, since it isn’t subject to damage from the weather and animals. Now trees like the balsa and some of the palms push their tops against the roof, 70 feet up. Visitors keep telling the Climatron staff that they’re going to have to cut back those trees.

“The joke is,” said Edgar Anderson, a staff member, “that a good many of them have been cut back, some of them repeatedly.” In fact, he added, cutting back, pruning and the removal of whole plants are among the Climatron’s main operations and the surplus vegetation is removed by the truckload. Scars are rapidly covered by new growth.

“We took out 60 trees just this past summer, and I’ll bet you can’t tell where they were,” put in Dr. Burch. I couldn’t, either.

The changes in temperature and humidity in the Climatron were apparent as we walked around the building. As we went from the dry, hot area—a little unpleasant—to the rain forest, I could feel the air becoming more moist. The “high tropics” area, where economic plants like coffee and cocoa are grown, was cooler. Occasionally, a big drop of water fell on my notebook as I wrote. In winter, I was told, the warm air hits the cold dome, causing moisture to form. It runs down to the metal supports, collects there and eventually drops.

Some visitors like the falling moisture, Edgar Anderson indicates—it reminds them of the real tropics,

where it's almost always dripping.

After inspecting the high tropics, we walked down a sloping path that took us to an area some 12 feet below the level of the rest of the Climatron—Little Hawaii. Here the air was pleasantly warm, with a cool breeze, a typical oceanic climate. Most of the flowering plants grow here. At one point we passed the sole commercial enterprise in the Climatron—a small nut machine vending, not peanuts, but Macademia nuts, a Hawaiian nut.

Little Hawaii has one exhibit that invariably draws "oh's" and "ah's"—a glass-walled pond divided by a path through which visitors can walk. The pond bottom is about waist high, so you look *up* at the surface of the water, an odd sensation. Tropical fish dart among water lilies growing in pots in the clear water.

"We've had more trouble with this pond than anything else in the Climatron," observed Dr. Burch. "We just got rid of an algae that made the water murky—now it's pretty clear." He pointed out a system of lights that illuminate the water.

In an actual pond, of course, the water would be somewhat murky, but the Climatron staff tries to improve on nature a little for display and educational purposes. "What we do is not reproduce but simulate," explained Dr. Burch as we climbed a flight of stairs back to the rain forest area. "In a real rain forest, for example, the vegetation grows straight up and it's very dark. But a real rain forest is too dull. We create this vertical effect but show some of the plants that grow in the tops of trees, too."

He pointed out a number of these little-seen plants that have been re-

moved to sites near the ground: orchids, ferns, a plant of the pineapple family. "You wouldn't see these at all in a rain forest unless you climbed up to the tops of the trees," he said.

The full potential of the Climatron hasn't yet been realized, Dr. Burch thinks. Plants that do best under certain conditions are growing under other conditions simply because space was available for them there. He and his staff are busy moving plants around so that all plants that like a dry, hot climate will be in the appropriate area, all plants that flourish in moist, hot zones will have optimum conditions, and so on. The changeover should take a few years.

He talked about his plans in front of the dry scrub area, now containing a number of plants other than those native to the climate. "This Bullhorn acacia is typical of the plants that will remain in this area," he says, pointing out a tall, sparsely-leaved plant with long thorns. "The palms will stay, too. If you'll look at these thorns on the acacia you'll see they're hollow. Ants live in them and protect the tree from other animals. They sustain themselves by eating parts of the leaves.

Will there be acacia ants in the new dry scrub area?

"No," he smiled. "They're a little too fierce for our visitors." Except for the tropical fish and a few native Missouri birds that get into the Climatron and can't (or won't) get out, animal life is one thing the Climatron lacks for true tropical realism, he admits. The small Climatron staff can't handle both animals and plants. "We're botanists, not zoologists," he points out.

Good ones, too.

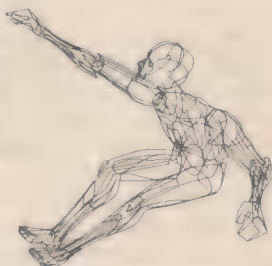
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An electric fog to smother asthma

Respiratory diseases may be helped by treatment with an electro-aerosol machine that charges salt water droplets with negative polarity for deep lung penetration.

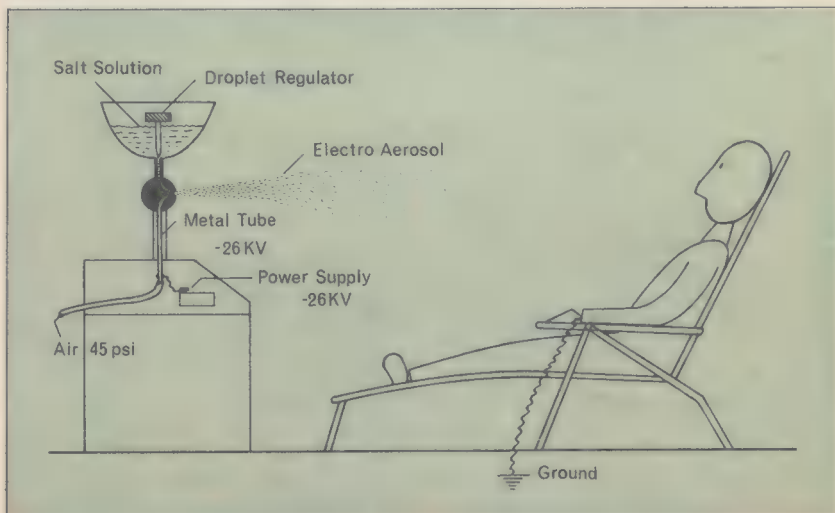
by Tom W. Hill

DANNY W., age eleven and a half, had suffered the miseries of asthma since infancy, and as he grew older, the attacks seemed to be growing worse and more numerous. At night he would wake up coughing and wheezing. In the daytime any form of activity would cause wheezing and shortness of breath. Danny

had never been able to play games with his brothers, run, ride a bike or even laugh at a joke without provoking exasperating attacks.

The family physician had prescribed practically all of the conventional remedies for asthma, but none of them seemed to do much good. As a last resort, he proposed to the parents that they try "electro-aerosol therapy," a comparatively new treat-

Electro-aerosol treatments consist of a jet of compressed air which atomizes a salt water solution. Particles of water are then charged by a 26,000-volt current. Diagram below shows routine of respiratory treatment which the patient undergoes regularly for a certain number of weeks.



ment introduced into this country by Dr. Alfred P. Wehner, who had organized an Electro-Aerosol Therapy Center in Plano, a suburb of Dallas, Texas. Danny's doctor had sent a couple of other patients to the E.A.T. Center and had been favorably impressed by the degree of improvement in their condition when he examined them again.

Young Danny was started on a series of electro-aerosol treatments. On weekdays for four weeks he spent 45 minutes in a small, air-conditioned room in which the only items of furniture were five aluminum and plastic lounge chairs. The only other object in the room was the electro-aerosol generator. In this unit a jet of compressed air atomized a salt water solution, breaking it up into minute particles averaging half a thousandth to five thousandths of a millimeter in diameter. A high voltage supply of direct current (26,000 volts) imparted an electric charge to the droplets. These charged droplets were the "electro-aerosol."

Before he had taken five treatments, Danny's asthma was noticeably improved. When he had completed the series of 20 treatments, his symptoms had completely disappeared for the first time in his life. That school term he played basketball and suffered none of the ill effects that formerly made it impossible for him to engage in any form of sports. Nearly three years after the end of this series of treatments, his mother writes that the improvement seems to have persisted.

Danny W. is just one among more than a thousand patients who have received electro-aerosol treatments in Dallas under medical supervision over a period of about five years. His

case is neither the least dramatic nor the most dramatic. Nor is asthma the only ailment that appears to be helped by this treatment. In general, its most effective applications are in the field of respiratory disorders.

In the summer of 1966 Dr. Wehner gave a paper on electro-aerosol therapy at an international Congress of Biometeorology held at Rutgers University and attended by physicians and scientists from some 30 countries. In it he reported specifically on 214 patients to whom he gave 2,930 treatments in 1964. Nine out of ten obtained relief. He divided them into four categories in evaluating their improvement:

- Excellent results (complete disappearance of symptoms)—30.3 percent
- Good results (significant to dramatic improvement)—42.3 percent

D. Alfred P. Wehner introduced electro-aerosol treatment into the U.S. He is quick to say that even though there is favorable evidence for the treatment, his clinical records are not yet scientific proof of therapy's effectiveness.



- Satisfactory to fair (definite but limited improvement)—20.0 percent
- Questionable results (including patients who said they "felt better," where no substantiation found)—7.4 percent

Children usually respond more dramatically to electro-aerosol therapy than adults. A girl who had had pneumonia nine times and a history of severe bronchial asthma since the age of three was given electro-aerosol treatments when she was eleven. In all her five years since starting school she had missed an average of two to three days per week because of frequent asthmatic attacks. After a series of electro-aerosol treatments she had only one attack (which was during the critical late winter and spring season) and missed only three days of school in four months.

Proof not yet conclusive

Dr. Wehner is quick to emphasize that his clinical records *do not* constitute scientific proof of the effectiveness of electro-aerosol therapy. The only way to prove something to the satisfaction of scientists is to conduct controlled experiments. In such experiments, one group of patients is given genuine therapy while another group (the "controls") receives some form of *pseudo*-therapy.

Actually, some experiments of this type *were* conducted at the former Veterans Administration Hospital in McKinney, Texas, by Drs. George R. Ellis and A. A. Swanson, with Dr. Wehner acting as technical consultant. The results were quite close to those observed clinically in the years since then. Dr. Ellis, who was at that

time the Chief of Physical Medicine and Rehabilitation at the V. A. Hospital, has reported* that:

"The majority of the 25 experimental patients showed various degrees of clinical and subjective improvement as compared to the 15 controls. Nonproductive night cough decreased or ceased in 23 of the patients. Increased expectoration of liquefied material resulted in improved bronchial hygiene. . . . Medication was discontinued or significantly reduced in all of the treated cases without adverse effects. Twenty-two of the treated patients reported easier breathing, 17 reported increased strength and energy, and 21 of the patients reported improved sleep. All of the treated patients reported improvement in their dyspnea (difficult breathing) on exertion and only one of the controls reported this effect."

The Veterans Administration researchers were especially impressed by the way in which difficult breathing was cleared up by the electro-aerosol treatments. The patients in these experiments were 45 to 80 years of age, with a mean age of 65.

The comment about "increased expectoration of liquefied material" describes a reaction that has been found to be characteristic of electro-aerosol therapy's effects. For a few days (usually between the third and tenth treatment) a person receiving therapy will develop an increase in the flow of mucus. Then the volume goes down to the insignificant amount experienced by normally healthy persons.

* In a paper at the Amer. Congress of Phys. Med. and Rehabilitation, Aug. 27, 1964.

The negative charge on aerosol particles helps them to reach deeply into the lungs.

Granted that electro-aerosol therapy seems to work, the logical next question is, "How does it bring about the improvements that have been observed?" Dr. Wehner says that it appears to be "more of a causal than a symptomatic therapy" (i.e., that it seems to attack the causes of an ailment rather than its outward symptoms). Its action on the human system is undoubtedly complicated. At risk of over-simplification, it can be said that there seem to be two aspects of electro-aerosols that contribute to their effectiveness:

1. The inhalation of plain and medicated aerosols has long been used for the relief of the symptoms of respiratory disorders. A unipolar electric charge on aerosol particles tends to stabilize them (because they repel each other, they will not combine as readily as ordinary droplets), making it easier for them to reach deep into the lungs.

2. The negative electric charge that is given to each particle in an electro-aerosol possesses, of itself, a beneficial effect. This has been demonstrated by many researchers. At the University of California, Dr. Albert P. Krueger and his associates, in a ten-year series of investigations, have performed a large number of experiments that demonstrate the biological effects of the minute charged particles of air that are called air ions. The action of electro-aerosols is not surprising, for it may be regarded simply as a practical means of delivering negative ions to the lungs.

Dr. Wehner was introduced to electro-aerosol therapy in Germany, where he received his education. In 1958, according to a paper published

in the *American Journal of Physical Medicine*, there were some 24 electro-aerosol clinics in Germany alone, several of them government-sponsored. E.A.T. is also used in Sweden, France, Finland, Hungary, Poland, Czechoslovakia, Spain, Russia, Italy, Yugoslavia, Brazil and South Africa. Having studied medicine and dentistry at the Johannes Gutenberg University of Mainz, in West Germany, Dr. Wehner did post-graduate work in the department of microbiology there. Aerosols were the subject of his doctoral thesis.

Some years after immigrating to the United States, he decided to introduce electro-aerosol therapy into this country. It wasn't easy. He found the medical profession skeptical, and it was an uphill battle to convince a few Texas doctors that it might work on their patients.

Within the past two years Dr. Wehner has begun to see developments leading to the establishment of new E.A.T. facilities in different parts of North America. For one thing, the electro-aerosol generators, which previously had to be imported, are now being manufactured in this country. Two units are now in operation in Florida and others are reportedly planned by doctors in Kentucky, California and Washington.

Electro-aerosol therapy might someday be a great boon to the more than 20 million Americans who suffer from "chronic obstructive lung disease." Dr. Wehner has no doubts that its use will increase steadily and that when E.A.T. is available in every state, it will be capable of checking the group of respiratory ailments that now constitute America's fastest growing killer.

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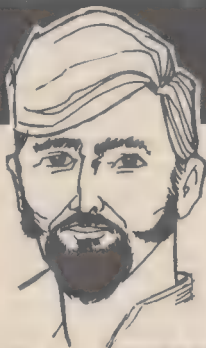
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SOLD ON MONEY BACK GUARANTEE



Husband, wife team play psychological marriage game. Their moves are hidden by board, but bargaining capabilities are measured by therapist, who later advises them on marital discord.

The marriage game

TO HELP HUSBANDS and wives avoid real-life collisions, a New York psychiatrist gets them to play a model-railroad game.

They sit on opposite sides of a large table. Before each is a toy railroad with a long and a short route that a train can take from start to finish. The players can see each others' faces, but a partition keeps them from seeing each other's moves.

Patent 3,418,729, granted recently to Dr. Robert A. Ravich, explains that the participants are asked to imagine that they are running competing railroad lines whose profits depend on the time a trip consumes.

If both husband and wife take the direct route on the shorter track, there is a simulated collision, and the only thing either of them can do is back up. The stops, starts, switching, reversing and trip times are displayed and recorded for the psychiatrist, who listens to what the players say.

Later the therapist analyzes the interaction patterns so he can advise

the participants on the solution of marital discord and emotional troubles. The bargaining capabilities of the participants are measured, rather than their imagination or intelligence levels.

Dr. Ravich has used the invention for several years in his own practice. He is director of the family therapy service in the Gouverneur health services program, affiliated with the Mt. Sinai School of Medicine and the Beth Israel Medical Center. He also serves as research associate for the Family Institute, which treats emotional problems.

The equipment for the "interpersonal psychological bargaining game-test" is to be marketed this year at about \$4,000 by the Interpersonal Testing Corporation. Dr. Ravich organized the company and assigned the patent to it. The game/test was designed for the corporation by Richard Doherty of Scientific Prototype Manufacturing Corp.

—Stacy V. Jones

The creative monkeys of Koshima



Monkeys on a tiny Japanese island have started a cultural tradition of their own. One of them learned how to wash his food before eating it—now they all do it.

by Barbara O'Connell

A YOUNG MACAQUE monkey on the little island of Koshima, Japan, dips a sand-covered potato in the sea and scrubs it briskly with its paw. When the potato skin is clean, the animal peels it off with its teeth and eats the potato.

Washing potatoes isn't ordinary behavior for a monkey. Monkeys in other areas, even nearby in Japan, don't wash their food. What makes the monkeys of Koshima do it?

The same group of monkeys, about 80 strong, follows another unique practice. They separate grains of wheat from sand by putting the sandy grains in water. The floating wheat is picked out and eaten. Who taught the Koshima monkeys this technique?

The evolution of a particular form of animal behavior isn't usually known, but the case of the Koshima monkeys is a little different. These animals and macaque monkeys in some 400 other colonies in Japan are among the most-studied animals in the world.



The Japanese macaque, a whiskery, medium-sized monkey with long, dense fur, is native to the country, but Japanese scientists didn't pay much attention to him until research on other monkeys around the world triggered their interest around 1950. Suddenly scientists realized that a prime subject for research was right in their own backyard.

Since that time, an extensive program of research on the animals has been undertaken with headquarters at Kyoto University. Results of re-

search both in Japan and elsewhere are published in a scholarly journal called *Primates* (it's printed in English) and an elaborate Japanese Monkey Center has been opened to the public and researchers at Inuyama.

Visitors are also welcome at other Japanese monkey colonies, except where the location is too remote as at Koshima.

Records are carefully kept at each colony on such data as the size of the group, the dominance order, births and deaths and any significant changes that take place. In smaller colonies like Koshima, almost every individual monkey is known, and many of them have been given names.

With records like this available, Japanese scientists can point out with some confidence that not long ago some inventive or "creative" female adult monkey on Koshima began washing the sand-covered potatoes left on the beach for the animals to eat. The potatoes are provided by a private society interested in maintaining the colonies.

Juvenile monkeys on Koshima watched the potato-washing female and imitated her actions. Soon a number of young monkeys could be seen industriously washing potatoes along the beach. No adult picked up the practice, however.

When the juveniles grow up, they'll continue washing potatoes, predict the scientists. They'll teach their young the practice and some day every monkey on Koshima will be washing potatoes and peeling them before they eat them. A cultural tradition will have been born.

Another creative female and the same sequence of events led, a little while later, to the grain separating be-

havior, the records indicate. Eventually this practice, too, will become a tradition.

These traditions in the making were filmed by an American scientist, Dr. R. C. Carpenter of Pennsylvania State University, and shown on television as part of a show entitled "The Evolution of Good and Evil." Dr. Carpenter shot the film, which will be available to scientists in Japan as part of the U.S.-Japan Cooperative Science Program.

In one of the sequences he filmed, a number of macaques are crouched on the Koshima seashore washing and peeling potatoes. An infant picks up and eats pieces of potato that his young mother drops for him.

"You can almost see the baby monkey learning how to wash potatoes," Dr. Carpenter says.

Separating wheat from sand

Another sequence he filmed shows a group of monkeys using different techniques to separate grains of wheat from sand. One throws the grains and sand in a stream, dashes downstream and picks up the floating grain. A more adept monkey holds grain and sand in his palm, immerses his hand in water and eats the grain.

An older female—too old, it seems, to have learned a technique—crouches downstream from a young monkey who is tossing grain and sand in the stream. The young monkey gets most of the floating grains but a few escape downstream, where the female grabs them.

Since grain separating is a newer practice, not quite as many monkeys are seen participating in it as in potato washing. And they seem, as Dr. Carpenter notes, less involved in the

practice and less excited about it.

What prompted the creative monkeys of Koshima to wash potatoes and separate grain?

Dr. Carpenter thinks they began the practice simply in order to survive. Although monkeys have lived on Koshima for about 300 years, the tiny, wind-swept bit of land doesn't offer its primate population an adequate diet. The macaques on Koshima are noticeably smaller than the macaques in other areas of Japan. The amount of potatoes and grain brought in from the mainland to supplement the animal's diet doesn't quite make up for the lack of food on the island.

It was to make as much food as possible available, then, that the creative monkeys began cleaning the

potatoes and grain that are simply dumped on the sandy beach, Dr. Carpenter theorizes. The cleaning not only increases the food supply, it protects the animals' teeth, he adds.

In a much larger monkey colony called Takasakyami on the big island of Kyushu, the macaques also are fed potatoes, but the vegetables are not covered with sand. Sometimes a Takasakyami macaque will dip a potato in water, apparently to coat it with salt, but he will not wash it as a Koshima monkey does. Would dirtier potatoes make a difference?

No one knows yet, but to test the idea there are plans to offer sand-covered potatoes to the Takasakyami monkeys. If there are any creative individuals among the colony, the results should be interesting.



"How'd it go? . . ."

ISAAC ASIMOV EXPLAINS

Each month Dr. Isaac Asimov chooses one of the questions you send in to answer. He does not make the job easy on himself, for in past months he has written about such things as relativity, parity and the basic nature of light. Following Dr. Asimov's answer are the answers to some of your other questions written by regular members of the *Science Digest* staff.



Ordinary vs. binary numbers

What is the difference between ordinary numbers and binary numbers and what are the advantages of each?

The ordinary numbers we use are "ten-based." That is, they are written as powers of ten. What we write as 7291 is really 7×10^3 plus 2×10^2 plus 9×10^1 plus 1×10^0 . Remember that $10^3 = 10 \times 10 \times 10 = 1000$; that $10^2 = 10 \times 10 = 100$; that $10^1 = 10$ and $10^0 = 1$, so that 7291 is 7×1000 plus 2×100 plus 9×10 plus 1. We say this when we read the number aloud. It is "seven thousand two hundred ninety (nine tens) one."

We have grown so accustomed to the use of powers of ten that we just write the digits by which they are multiplied, 7291 in this case, and ignore the rest.

But there is no magic about powers of ten. The power of any other number higher than one would do. Suppose, for instance, we wanted to write the number 7291 in terms of

powers of eight. Remember that $8^0 = 1$; $8^1 = 8$; $8^2 = 8 \times 8 = 64$; $8^3 = 8 \times 8 \times 8 = 512$; and $8^4 = 8 \times 8 \times 8 \times 8 = 4096$. The number 7291 can then be written as 1×8^4 plus 6×8^3 plus 1×8^2 plus 7×8^1 plus 3×8^0 . (Work it out and see for yourself.) If we write only the digits we have 16173. We can say, then, that 16173 (8-based) = 7291 (10-based).

The advantage of the 8-based system is that you only need to memorize seven digits besides 0. If you try to use the digit 8, you might have 8×8^3 which is equal to 1×8^4 , so you can always use a 1 instead of an 8. Thus 8 (10-based) = 10 (8-based); 89 (10-based) = 131 (8-based) and so on. On the other hand there are more total digits to the number in the 8-based system than in the 10-based system. The smaller the base, the fewer different digits but the more total digits.

If you used a 20-based system,

the number 7291 becomes 18×20^2 plus 4×20^1 plus 11×20^0 . If you wrote 18 as # and 11 as % you could say that #4% (20-based) = 7291 (10-based). You would have to have 19 different digits in a 20-based system but you would have fewer total digits per number.

Ten is a convenient base. It gives us not-too-many different digits to remember and not-too-many separate digits in a given number.

What about a number based on powers of two — a 2-based number? It is this which is a "binary number," from a Latin word meaning "two at a time."

The number, 7291 equals 1×2^{12} plus 1×2^{11} plus 1×2^{10} plus 0×2^9 plus 0×2^8 plus 0×2^7 plus 1×2^6 plus 1×2^5 plus 1×2^4 plus 1×2^3 plus 0×2^2 plus 1×2^1 plus 1×2^0 . (Work it out and see, remembering that 2^9 , for instance, is nine two's multiplied together: $2 \times 2 \times 2 \times 2 \times$

$2 \times 2 \times 2 \times 2 \times 2 = 512$.) If we write only the digits we have 1110001111-011 (2-based) = 7291 (10-based).

Binary numbers contain only 1's and 0's, so that addition and multiplication are fantastically simple. However, there are so many digits altogether in even small numbers like 7291 that it is fantastically easy for the human mind to become confused.

A computer, however, can use a two-way switch. In one direction, current-on, it can symbolize a 1; in the other direction, current-off, a 0. By manipulating the circuits so that the switches turn on and off in accordance with binary rules of addition and multiplication, the computer can perform arithmetical computations very quickly. It can do it much more quickly than if it had to work with gears marked from 0 to 9 as in ordinary desk calculators based on the decimal or 10-based system.

—Isaac Asimov



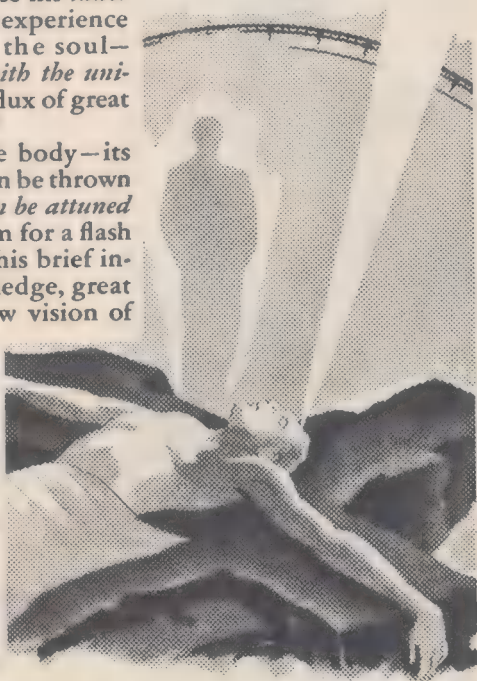
"Okay now, at the count of three—everybody pull."

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QUIZ



UPI

Mammoth clouds of ash rise from an active volcano in Costa Rica. Although few were seriously injured from this particular volcano's wrath, over 200,000 deaths have resulted from other volcanic activity in the past.

Volcanoes— from dormant to deadly

by John and Molly Daugherty

THERE ARE about 500 active volcanoes in the world and thousands of dormant and extinct volcanoes. Man has looked on them with both awe and fear because of the death and destruction they cause. Yet in the past 500 years only 200,000 deaths have resulted from volcanic activity. This total is small compared to the deaths from other natural calamities such as earthquakes, floods, famine and pestilence. In China nearly a million people drowned in a flood of the Hwang Ho River in 1887 and 800,000 Chinese died in one earthquake in 1556.

What do you know about volcanoes?

1. Of these eruptive types of volcanoes, the one considerably violent and quite deadly, yet without liquid lava flows, is the
 - a. Peléan
 - b. Hawaiian
 - c. Icelandic
2. Of the volatile (gaseous) products emitted from volcanoes, the most abundant is
 - a. Sulfurous vapors
 - b. Water vapor (steam)
 - c. Carbon dioxide
3. Three substances are associated with volcanoes. One strictly classed as solid rock fragments is
 - a. Lava
 - b. Magma
 - c. Pyroclastics

4. Lava may be classed into three categories based on the amount of silicon dioxide present in the mix. This affects the viscosity of the lava. In general the lava which is least viscous (quite fluid) is

- a. Basic lava
- b. Intermediate lava
- c. Acidic lava

5. Volcanic dust consists of particles less than .01 inches across. Ash is larger—up to .15 inches in length. Lapilli are little stones, and volcanic bombs and blocks are larger. The blocks are largest of all. The largest block emitted from ■ volcano appears to be that from the volcano

- a. Stromboli
- b. Vesuvius
- c. Cotopaxi

6. Modern measurements show that in 1912, volcanic activity covered 53 square miles of a valley with ejected material to a depth of 700 feet in some parts near the volcano of

- a. Crater of the Moon Monument
- b. Novarupta
- c. Mount Lassen

7. Never before has man so fully recorded the life of a volcano as when one was born in a cornfield in Mexico on Feb. 20, 1943. It was studied continuously until it died out in 1952. This was the volcano

- a. Parícutin
- b. Bárcena
- c. Jorullo

8. That part of the Americas having more active volcanoes per square mile than any other land surface is

- a. Alaska
- b. South America
- c. Central America

9. A volcanic island, northeast of New Zealand and first discovered in 1885, has put on a disappearing act quite

■ few times with ■ reappearance at other times. This is

- a. Niuafoo Island
- b. Tonga Island
- c. Falcon Island

10. About 50 volcanoes on the Island of Java are looked upon by the Javanese as beneficial, especially because

- a. They increase the fertility of the soil.
- b. They increase the water supply
- c. The geothermal heat from them can be used.

Answers

1—a Peléan. In 1902, a hurricane of fire swept over Saint-Pierre on the Island of Martinique in the Caribbean when Mount Pélee exploded, ripping open its side. Only two in a city of 30,000 survived the glowing cloud with its superheated gases and glowing solid particles. The emulsion-like dense cloud travelled laterally over the city in a few minutes at speeds so great only one of 18 vessels in the harbor escaped. The others capsized or burned.

2—b Water vapor (steam). The gases emitted from a volcano vary among eruptions and also among different volcanoes. But water vapor is always the most abundant volatile material. Next in order usually are carbon dioxide, sulfurous vapors and nitrogen.

Sometimes the weight of volatile substances exceeds the weight of liquid lava and solid substances combined. This has been true of certain eruptions of Vesuvius.

3—c Pyroclastics. These are solid rock fragments. Lava, which may

solidify, is generally applied to name the liquid state. Often called magma, it comes from molten rock within the earth.

4—a Basic lava. These are basalts, dark in color, with less than 52 percent, by weight, of silicon dioxide (SiO_2) in the lava.

The acidic lavas or rhyolites contain a minimum of 65 percent silicon dioxide which produces a highly viscous lava even at high temperatures, so there is seldom a lava flow.

5—c Cotopaxi. This giant volcano is in Ecuador. It hurled a pyroclastic block weighing about 200 tons nearly nine miles from its vent.

A violent eruption of Stromboli in 1930 threw a block of nearly 30 tons a distance of two miles.

Pompeii was destroyed by volcanic ash and pyroclastics covering the city. There was no lava in Pompeii.

6—b Novarupta. At first it was believed that Mount Katmai in Alaska, five miles from Novarupta, was the source of this gigantic eruption. Later studies show that Katmai didn't blow 1,000 feet off its top—instead, it collapsed. This was caused by the reservoir of magma under Katmai draining off to the lower volcano Novarupta. The volume of erupted material from Novarupta was about seven cubic miles with a total weight of 33 million tons.

7—a Parícutin. Within a day it rose 30 feet. In about a week its height was 500 feet. In five months the volcano reached 1,000 feet. Finally after two years it attained 1,500 feet. An estimated 2,227 metric tons of pyroclastics and 1,356 metric tons of

lava erupted before the volcano died.

Jorullo was born in 1759 in Mexico in a remote area at a time when a volcano was to be feared—little is recorded about it.

Bárcena, an underwater volcano, appeared in 1952 off the Pacific coast of Mexico 200 miles south of Baja California. It was 1,000 feet above water within two weeks.

8—c Central America. Its volcanoes are diversified, and all eruptive types are represented here such as Peléan, Hawaiian and strombolian. Near San José, Costa Rica, there are about 75 ash-producing volcanic cones. The Irazu cone plagued San José with ash falling almost constantly for several years (1963-1965).

9—c Falcon Island. It was first charted by the *H.M.S. Falcon*—whence its name. In 1877 it was gone, but back again in 1885. This was repeated several times until in 1928 when its size was a maximum—about two miles long and 365 feet above sea level. The queen of Tonga claimed the island.

Each time it appeared, erosion cut into the island of unconsolidated debris which lacked a lava foundation. Presently it is only a shoal.

10—a They increase the fertility of the soil. Volcanic materials are rich in minerals, and even the rock fragments are eroded by the elements in time to make good soil.

Answers b and c also are beneficial effects, but to a lesser degree.

Score yourself:

9—10	right	Explosive
4—8	right	Quiescent
0—3	right	Dormant

A 'no' vote for the UFOs

Scientific Study of Unidentified Flying Objects (conducted by the University of Colorado under research contract with the U.S. Air Force). Dr. Edward U. Condon, Project Director. Bantam Books. (\$1.95).

All the weight of modern science can't resolve some problems when emotions run high and facts are scarce. The University of Colorado's negative report on UFOs, a two-year, \$500,000-study involving 37 staff members, numerous outside experts, miles of tape recordings and elaborate laboratory analyses, was hardly in print when believers in flying saucers were denouncing its conclusions. In Washington, the National Investigation Committee on Aerial Phenomena (NICAP), which had suggested some of the 59 cases the Colorado project studied, called a press conference at which two scientists attacked the study and called for another investigation.

One was Dr. David R. Saunders, ■ psychologist who at one time was ■ member of the very University of Colorado investigative team he now denounces. Dr. Saunders has written his own report, *UFOs? Yes!*, the publication of which coincided (by design) with that of the Colorado study. Its subtitle: "Where the Condon Committee Went Wrong." Claiming that the Colorado study is a cover-up, Dr. Saunders pushes the idea of a conspiracy participated in



UPI
Famous disk-like UFO photographed by farmer in McMinnville, Ore., is one experts in the Colorado report admit they can't explain.

by government officials to mask the truth. The truth, Dr. Saunders thinks, may be that unexplained sightings of UFOs are interterrestrial vehicles.

The 1,485 pages of the Colorado study, which was headed by Dr. Edward U. Condon, a University of Colorado physicist, effectively explains all but ■ few of the sightings it investigated. Among the cases it solves is the much publicized "Ubatuba Incident," which Dr. Saunders cites in his book as one of the three "facts" that lead him to conclude that UFOs might be from outer space.

The story goes that back in 1957, a metal flying disc exploded over the

Brazilian coast, where fragments were picked up by a fisherman. The fragments were examined in a laboratory and found to be a finer quality of magnesium than anything that could be produced on earth. The Colorado project obtained a sample of the mysterious metal, which was subjected to the most sensitive analysis available. The sample, they report, is not nearly so pure as commercial magnesium produced in the year 1957 by Dow Chemical Company. Furthermore, the unusual pattern of impurities in the sample was characteristic of a Dow magnesium made as early as the 1940s.

Some of the explanations advanced by the Colorado study produce a chuckle. One terrified homeowner in the Northwest reported an eerie beeping sound that swept over his house every night. The culprit: a small saw-whet owl that's hard to see in the dark. Police in a southeastern state, who were "pursued" by an illuminated flying object that came from the east in the early morning hours were looking at the planet Venus, then exceptionally bright. A UFO of fantastic maneuverability in Colorado was traced to two high school boys who had launched a hot-air balloon.

Quenching as these explanations are, flying saucer buffs tend to pass over them and attach great significance to the handful of cases the Colorado report admits it *cannot* explain. Among these is the "McMinn-

ville Case." In May 1950, a farmer's wife in McMinnville, Ore., saw a metal disklike object glide across the sky; she called her husband, who shot two rather fuzzy photographs of a plate-like object that appears to have a superstructure. The two were so little interested in the photographs that they waited until Mother's Day to finish the roll of film, then let their children play with the negatives. A newsman who had been tipped off to the story fished the negatives out from under a sofa and McMinnville was on its way to fame in UFO circles. The farm couple remained unimpressed.

According to the Colorado report, "This is one of the few UFO reports in which all factors investigated—geometric, psychological and physical—appear to be consistent with the assertion that an extraordinary flying object, silver, metallic, disc-shaped, tens of meters in diameter and evidently artificial, flew within sight of two witnesses."

For proponents of the flying saucer theory, one case like this is enough to raise doubts of the efficacy of the Colorado project. We'll be hearing more from the buffs about UFOs, but for the scientific fraternity, the subject is a closed book unless and until some hard enough evidence is produced to re-open it. All told, the Condon report is a pretty cold bucket of water that should dampen the spirit of all but the most persistent buffs.—*B O'C*

Other new books of interest

Bankers, Bones and Beetles. Geoffrey Hellman. The Natural History Press. (\$5.95). Subtitled "The First Century

of The American Museum of Natural History," this lively volume gives you a behind-the-scenes look at the famous museum now celebrating its 100th birthday. Personalities and an-

ecdotes abound, all described with the sprightliness of a *New Yorker* "Talk of the Town" piece by a regular contributor to those pages.

The Kensington Rune Stone. Theodore C. Blegen. The Minnesota Historical Society. (\$4.50). The old riddle of the Kensington rune stones still lingers. (See "Riddle of the Viking Cryptograms," *Science Digest*, January 1969). Opposing sides continue to battle the authenticity of the runic inscription found on the stone near Kensington, Minn., in 1898. The author has chronicled the debate, presented the evidence he has diligently researched and come up with the view that the stone is not authentic.

Animal Societies. Rémy Chauvin. Hill and Wang. (\$6.50). When one delves into the social existences of animals other than man some interesting resemblances to man can be seen in some forms. This author deals with insect societies rather than insect as individual organisms. Each insect is important only as being part of a whole. Anyone with any interest in animals—insects, birds, fish, mammals—will find this a thoroughly interesting book.

The Story of Quantum Mechanics. Victor Guillemin. Charles Scribner's Sons. (\$8.95). Quantum mechanics, or the "new physics" as it is often called, deals with the sub-microscopic world of atoms of which every material substance is made. This is the story of its beginning and its present. Although expertise in physics is not required to read and enjoy this story, a strong interest and some knowledge in the subject would be helpful.

Russians Learn While Asleep

(WE KNEW IT ALL THE TIME)

News items appearing in newspapers and magazines throughout the nation report that: "In the Kiev State University, a woman student mastered a complete course in English in 28 nights."

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use any amount of interesting, scientifically accurate material. There is a great deal of material in the old Digests that would be invaluable if it could be made available.

MRS. MYLES L. COLGAN
King Perry, N. Y.

Back issues of Science Digest have been microfilmed and are available as supplementary reading for science students. Complete information on this service to be obtained from: University Microfilms Library Services, Xerox Corp., Ann Arbor, Mich. 48106.—Ed.

Unearthing another rune

After reading Mark Roberts' provocative (and provoking) article on "Viking" cryptograms, as well as your editorial comments, I tremble at the thought of a whole new generation of rune readers, cryptograph finders and theory spinners turned loose on us weary pillars of the scholarly establishment. No doubt we will survive it, though. We skeptics are a hardy lot.

In the meantime, your readers might be interested in two recent works on the subject. The first is an article published in the spring 1968 issue of *Minnesota History*. Copies may be obtained from the Minnesota Historical Society, St. Paul, Minn. 55101. The second is a book, *The Kensington Rune Stone: New Light on an Old Riddle*.

MRS. RHODA R. GILMAN
Assistant Managing Editor
Minnesota History

For a review of The Kensington Rune Stone, see page 90.—Ed.

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Underground fires—future volcanoes?

I read the article "Creeping Fire Underground" in the September, 1968 issue of *Science Digest*. It has me puzzled. If the heat of these fires is uncontrollable and the pressure keeps building up, can this in time become a giant volcano?

WALTER FLESAK
Philadelphia, Penn.

While mine fires can generate a heat approximately 3,000°F. in the presence of sufficient oxygen, fires in abandoned mines, such as those dis-

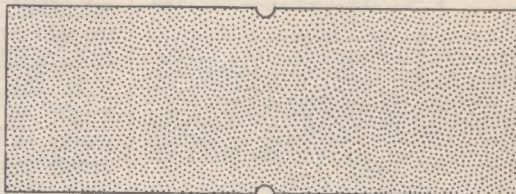
cussed in the Science Digest article, seldom exceed 1,000°F. They are generally slow-burning under a low oxygen supply due to lack of adequate ventilation in the mine. The Bureau of Mines has no knowledge of any fire that produced pressures similar to those found in a volcanic environment.

Thomas P. Flynn Jr.,
Acting Chief,
Division of Environmental
Activities
Bureau of Mines
U.S. Department of the
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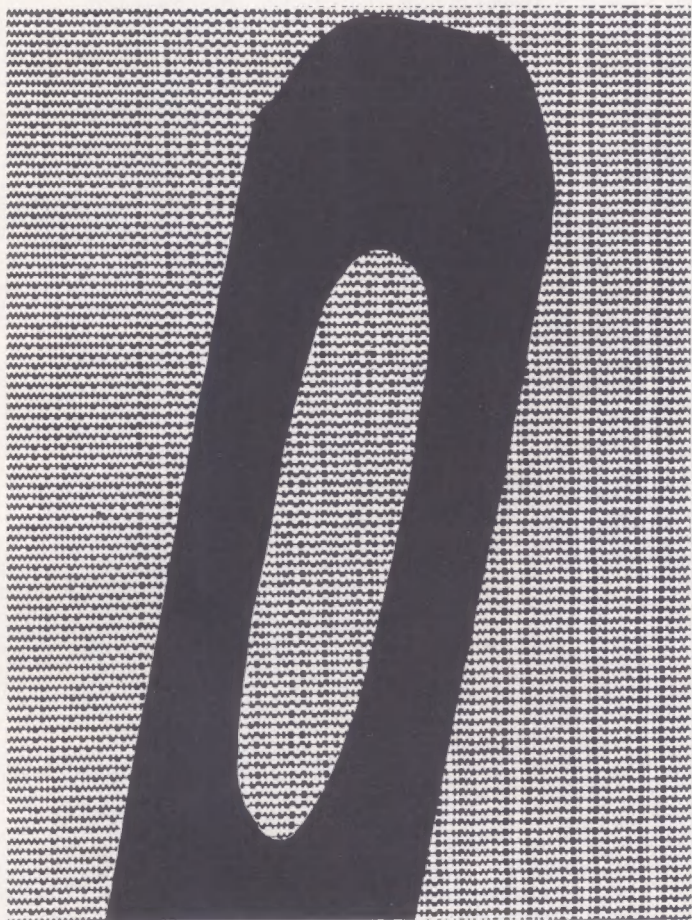
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